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GERMANIA—A COLOSSAL STATUE FOR THE LEIPZIG MONUMENT, BY PROF. R. SIEMERING.

IN the hall which is next to the hall in the dome of the Art Exhibition Building, Berlin, the gigantic statue of Germania rises from its pedestal, which is surrounded by groups of blossoming plants. This statue—represented in the accompanying cut—is the work of Prof. R. Siemering, of Berlin, who has produced so many of the monumental works of our time, notably the statue of Frederick the Great at Marienburg, of Von Graefe at Berlin, Luther at Eisleben, and Washington at Philadelphia. This statue of Germania will crown the great monument to be erected on the August Square in Leipzig to commemorate the Franco-German war, the union of the German nation, and the re-establishment of the Empire, and in honor of the Emperor, of the German Army, of the renowned leader of the same, and of the Chancellor.

This monument will be one of the grandest compositions of the century. Equestrian statues of the German Crown Prince, the King of Saxony, the Chancellor, and the Graf Moltke are placed at the corners of the pedestal, in a niche on the front is a statue of the Emperor William seated, while groups of warriors of the German army with their flags and standards decorate the other faces of the pedestal. This heavy, harmonious mass forms the base for the beautiful giantess in whom we see the embodiment of the individualities of the German people.

Siemering conceived his Germania as equipped for war, but quiet in the consciousness of strength and victory. She stands ready to step lightly forward, with her head turned a little to the left. Her left hand rests on the upper edge of the shield bearing the eagle, which rests near her on the ground, and in her right hand she holds the lower end of a sheathed sword, so that the hilt rests on her shoulder. A brocaded mantle falls over the back of this beautiful figure, and is fastened over the breast by a chain clasp. One corner of the mantle is drawn through the girdle, forming graceful folds, which, while they cling to the limbs, at the same time reveal their movement. The tight, leather-like armor which covers the upper part of the body has decorations similar to those on the mantle.

Instead of the cold, smooth, copper-like luster of the bronze, Siemering likes to give his metal work interesting tones of color, which he accomplishes by means of the subduing patina and of gilding in certain parts. He has made use of these methods specially in the treatment of his Germania, which was cast by Gladenbeck, in Berlin, thus giving life to the otherwise monotonous surface of the bronze. The gilding of the groundwork, throws the design of the mantle and the armor into strong relief, heightens the effect of the eagle on the shield, and greatly increases the impression of power, strength, and dignity given by the magnificent, harmonious whole.—*Illustrirte Zeitung.*

BERLIN ART EXHIBITION.—STATUE OF GERMANIA.—BY R. SIEMERING.

FOR a preparation that will remove stains from black walnut, the stains being those of liquor, etc., use alcohol; oxalic acid and water are sometimes used to remove stains from mahogany furniture.

RECENT ENGINEERING PROGRESS.*

THE field of engineering science has of late years become so extensive, that the task imposed on your president of giving a summary of engineering progress during the year is one of considerable magnitude. To make such a summary exhaustive, the records of all civilized countries would have to be searched, and the merits of new methods and appliances carefully weighed, so that only those which have proved, or given promise, of real value may be brought to your notice.

It would be impracticable within the limits of this address to even enumerate all the important engineering works commenced or completed during the year; and to present simply a statement of the dimensions and cost of such works would be of slight interest or benefit to the members of the society. I have, therefore, concluded it would be preferable that I should mention some of the most important works only, and devote a portion of this address to a statement of my individual views on such other matters as I judge to be for the well-being and progress of the profession. Even if some of my views should be shared by but few of those to whom I speak, no harm can ensue, as, very properly, the society is not responsible for the individual opinions of its members. Furthermore, a departure from precedent to this extent, and from what may be termed the strict construction of the by-laws, will doubtless lead to more general consideration of the subjects to which I refer.

This is another point on which I propose to depart from the beaten path. Instead of giving the greatest prominence to those works of the engineer which never fail to excite general admiration, by being either the largest or the most difficult, or perhaps the most expensive, I propose to give the first consideration to that part of the work of the engineer which more directly influences the health and comfort of the human race.

I will, therefore, commence by referring to municipal engineering, by which I mean those branches of engineering which provide abundant and pure water, good streets, and safe buildings, and which keep pestilence from our dwellings by providing for the prompt removal of all offal and *debris*, or by applying proper means for destroying their power to work harm.

A liberal supply of wholesome water is an essential condition for health and comfort. This has been recognized most fully in our own country. Even the smallest towns are erecting water works, and the large cities are either extending their existing works or are engaged in investigating the best method for improving, as well as for increasing, their supply of water.

When the planning and construction of works of this kind is intrusted to experienced and skillful engineers, as is generally the case in our large cities, and when the usefulness of the engineer is not impaired by the interference of politicians or of another class of men who may be called amateur engineers, the works are substantially constructed with a view to economical operation, and with due regard to the necessities of the future.

In the smaller cities or towns the mode generally adopted is for one of the many water-work companies or syndicates to undertake the planning and construction of water works under a contract by which they guarantee a number of fire streams of a fixed height at a certain price per annum, and also to supply water to the inhabitants at a rate agreed upon. But as the engineer in charge of the municipal work too often has no special knowledge of hydraulic engineering, it is but natural that in most cases the lowest bid will be accepted, and just as natural that the company or syndicate which obtains the franchise for the construction and operation of the works should plan them with a view to cheapness in first cost, and without any regard either to the quality of the water to be furnished or to the permanancy of the works. That under such a system many of the water works of our smaller cities should be more or less failures is hardly to be wondered at.

There are a number of companies in this business which have a reputation to uphold, and employ competent engineers to plan and to construct the works for which they contract; but unless the city authorities should possess greater wisdom and knowledge of hydraulic works than they are ordinarily gifted with, some speculating syndicate will underbid, as it safely

* Address at the Annual Convention, at Denver, Col., July 2, 1886, by Henry Flad, President American Soc. C. E.

may, the responsible firm or company, and by building poor works inflict a lasting injury on the community.

Of new devices used in operating water works, I may call attention to the aeration of water, by means of air introduced into the pipes under pressure, for the purpose of destroying the organic germs which otherwise might affect the salubrity or taste of the water.

A new method of investigating the purity of potable water has also been introduced. It consists in observing the colonies of microbes which are produced in gelatine that has previously been sterilized. This method was first used in Berlin, and probably leads to more correct conclusions in regard to the salubrity of the water than any chemical analysis.

As regards cleaning the water from solid matter carried in suspension, our country cannot claim to have reached the high standard that obtains in other countries. American practice, in cases where the water is taken from turbid streams, generally provides only for removing so much of the material held in suspension as will subside during a certain period of quiescence in settling basins.

Filtration, so largely used in England and on the Continent, is used here in but few instances. One reason why it is not more generally adopted probably lies in the fact that the quantity of water consumed *per capita* in this country is largely in excess of all legitimate requirements. Of late years the quantity *per capita* has been reduced by various means adopted to prevent waste. If efforts in this direction are continued, and are reasonably successful, measures for improving the quality of our potable water will probably be more generally adopted.

The most important and extensive works for the supply of water which are being carried on at present are those of New York, in the United States, and Liverpool, in England. The New York works are intended to provide an ultimate daily supply of 320,000,000 gallons. The main features are a masonry dam, 178 ft. above the bed of the stream, and 1,300 ft. in length, forming a lake, which will contain 3,200,000,000 gallons. As the masonry of the dam must be sunk more that 100 ft. to reach solid rock foundation, its total height will be nearly 300 ft., and its width at the bottom about 200 ft. The aqueduct which is to carry the water to the Central Park reservoir is to be 31 miles in length, and of an average diameter of 14 ft. It will cross the Harlem River by an inverted siphon, 150 ft. below tide level. The construction of the aqueduct is rapidly progressing.

Of similar character, and of hardly less magnitude, are the works for the supply of water to Liverpool. The Vrynwy Dam, of Cyclopean masonry, is to be 136 ft. high in the center, 1,258 ft. in length, and 117 ft. thick in its widest part, and the impounded water will cover 1,118 acres. The aqueduct will be 35 miles in length.

The work of the engineer next in importance, if its effect on health be made the criterion, consists in providing for the removal of all refuse matter which, if allowed to remain, would affect the health or comfort of the community. The need of works of this kind has become so fully recognized of late years, that their construction has grown into a special branch of engineering.

The removal and disposal of human *excreta*, and of the waste water from dwellings and factories, present greater difficulties than that of any other kind of refuse. Both scientific attainments and experience are required in the engineer who undertakes to select that system of sewerage which is best adapted to local conditions and requirements. The system of carriage by water is evidently the only one practicable in a country where the water closet is so generally used as in the United States.

Whether sewage proper should be taken into the conduits which, in most cities, it is necessary to construct to carry off storm water, or whether it should be carried off separately—in other words, whether a combined or separate system of sewerage should, for any particular city or town, be chosen—cannot be properly determined without thoroughly weighing the advantages and disadvantages of either system, as applied to the particular place requiring the improvement. To insist that one of these systems should be exclusively used in all cases is, in my opinion, a position which the engineer ought not to assume.

With the combined system, the only rational method for the final disposal of sewage consists in its discharge into large bodies of water in motion, except, perhaps, where extensive tracts of sandy soil are available.

Instead of entering into a discussion of the different methods used for finally disposing of the sewage under the separate system, I will state that, in my judgment, the filtration of sewage, by allowing it to flow over large areas of under-drained land (as is practiced with perfect success in many towns in England, and which has also been introduced at the city of Pullman, Ill.), is the most certain and most generally applicable method.

The appliances for receiving the sewage and conducting it from the houses—or what may be designated as plumbing fixtures—have lately been receiving much more attention than formerly, and our people are slowly learning, some of them by dire experience, that in building dwellings they should look to perfect design and workmanship in the execution of plumbing work, rather than to its cheapness, if they desire to secure healthy homes.

Speaking of the disposal of refuse matter, I will mention that the burning of street sweepings and offal, in ovens constructed for the purpose, is successfully and economically carried on at Leeds and other places in England, and express the hope that the example will soon be followed in our own country. But the burning of street sweepings can be economically carried out only when the pavements are constructed of material which is not readily abraded by the traffic.

The necessity of procuring pavements of this kind is fully recognized, and the streets of Paris, London, Berlin, Vienna, New York, Boston, Chicago, St. Louis, Baltimore, Cincinnati, and Washington are now nearly all being paved with the same kinds of material, and under almost identical specifications. Granite blocks, wooden blocks, and monolithic asphaltum are almost exclusively used in the principal streets of these cities. The granite pavement is the most durable and requires the least repairs; the monolithic asphaltum takes precedence from a sanitary point of view; and the pavement made of blocks of wood, as lately constructed, is preferred by some on account of its being easiest on horses and least noisy. But it still remains for the engineer to devise a pavement, durable and smooth, for use on streets where the traffic is not heavy enough to require granite, or where the cost of either of the two other pavements above mentioned is too great to justify their application.

Macadam pavements, when good stone can be obtained, will, under proper treatment, give a smooth surface, agreeable for travel, provided they are kept in first-class order by the immediate repair of any defect. But this is a condition which can hardly be realized in this country on account of the high price of labor.

Street pavements of hard-brunt brick are now being tried on a large scale in a number of towns in Illinois. At Bloomington such a pavement has been in use since 1876. Blocks composed of coal tar, pitch, and sand, and called ceramite, have been used for street pavements at Buda-Pesth since 1881. Both these pavements are laid in a similar manner.

A street pavement of round cedar blocks has been largely introduced in Western cities of late years, but can hardly be considered to fill the conditions required for a good pavement, on account of the unequal wear of the sap and heart wood.

Among the things which affect the health and comfort of the inhabitants of cities using bituminous coal, is the smoke from factories and dwellings. Many appliances for smoke prevention have been devised, some of which are reasonably successful. Their application mitigates the evil, if it does not wholly remove it; but it is to be hoped that the experience gained at points where natural gas has been found and applied to heating purposes, and the late improvements in the manufacture of heating gas, will before long lead our people to abandon the primitive mode of heating with solid fuel now in vogue, and thus abate the smoke nuisance.

A new problem is pressing itself upon the attention of the municipal engineer—one that presents special difficulties, and will require his best endeavors to satisfactorily solve. This is the proper method of arranging and carrying the numerous wires required for the electrical appliances which are now used in our cities and towns. In the larger cities, where space is limited and the purposes to which electricity is applied are various, necessitating the employment of all kinds of electrical currents, many of which act injuriously upon each other, the electrical difficulties to be overcome are great, and by many are considered to be of such magnitude as to forbid the use of routes or ways in common. In the larger cities the public demand that the wires shall be placed underground, and undoubtedly they must be so placed to a greater or less extent.

The electrical difficulties need not be considered here. The engineering difficulties are in themselves of sufficient importance. The solution of the problem which most naturally suggests itself is the building of large subways, in which all the wires may be placed, as well as the water and other pipes, pneumatic tubes and other modern appliances; the subways to be of a size admitting men to enter at convenient points for placing and repairing the wires and pipes without interfering with the street traffic. The cost of such subways would be so great as to forbid their construction except to a limited extent.

On the other hand, the use of small conduits or tubes, into which the wires shall be drawn through numerous openings in the street surface, will necessitate almost constant interference with traffic, and frequent disturbance of the pavement of the streets and sidewalks for enlargements and repairs, and for making connection with buildings.

I am inclined to think that what may be designated as the mixed system would be the most satisfactory, under which large subways would be used on streets where the number of electric conductors and of pipe lines required for all purposes was sufficient to warrant the expenditures for such structures, while for the other streets a system of aerial carriage and distribution might be devised which would be free from the gravest objections to the present practice, and which would admit of gradual expansion without interrupting traffic until the proper time for the construction of a subway had arrived.

Before dismissing the subject of municipal engineering, I desire to say a few words in regard to the difficulties which are in the way of a proper management of the engineer department of our cities and the means of removing them; not specially for the benefit of the profession, but of the community at large. The greatest obstacle to the proper conduct of public work in cities and villages arises from the fact that the engineer is frequently selected from political preferences, which often gives the position to an incompetent man. Another obstacle is that the term of office is generally limited by law to one or two years, which does not allow enough time for even a competent engineer to become thoroughly acquainted with his duties, and with the distinctive features and requirements of the locality, before he is liable to be displaced. If the evils arising from such a state of affairs are to be avoided, appointments should be based on strict civil service principles. No person should be appointed on any other ground than that of competency and honesty, and he should hold his office during good behavior; and all subordinates should be selected on the same principles.

Some of our large cities, recognizing the evil effects of political appointments of officers in charge of public works, and of frequent changes, have tried to remedy these by placing the general government in the hands of boards of commissioners, generally selected from among prominent business men in the community. Changes of this kind have usually been made when a reform wind was blowing, it being supposed that, although changes in the members of these boards might take place, the intelligence of such a class of men would be a guarantee against causeless changes of employes. This system, while it has been an improvement on the old one, has the disadvantage that members of these boards are too often hardly more than figure-heads, whose duties might just as well be performed by the engineers intrusted with the planning and execution of the public works. To make a board of public works thoroughly useful, the majority of the members should be engineers, each of whom should take charge of a particular department as its chief. By this system the board would have the benefit of the special information of each member as regards his own department, as well as of his general knowledge of engineering matters. St. Louis, Providence, and Milwaukee have partially adopted this system, and it is to be hoped that other cities will follow their example.

In connection with this subject, I am pleased to record the fact that in some cities positions on public works are now made dependent on the result of examinations held under civil service rules.

Next in importance to municipal engineering, I consider the work of the railroad engineer.

During 1885 about 3,000 miles of railroad were constructed in the United States. This is less than for any one year since 1878; yet there seems now to be some revival in railroad construction, as from January 1 to June 1, 1886, 1,100 miles of railroad have been constructed, as against 600 miles during the corresponding period of 1885.

The total mileage of railways in the United States may now be taken as about 129,500 miles.

The rapid increase of railroad traffic, and the introduction of freight cars carrying as much as 60,000 pounds, has directed the attention of railroad managers to the necessity for the improvement of brakes for freight trains.

In a paper read before our society, it has been stated that the number of freight cars in the United States provided with power brakes on June 1, 1885, probably did not exceed 4 per cent. of the total number. In June, 1885, the Master Car Builders' Association instituted a series of experiments, with a view of determining the merits of different brakes proposed for freight service. Another set of experiments upon automatic brakes is to be made under the auspices of the same association, at Burlington, Ia., on July 13, 1886, in which the best brakes now in use will be brought into competition. The results of such competitive tests will be of great value to railroad interests.

Of the various devices used for increasing the safety of railroad operations, one of the most effective and important is the block signal system, almost universally used in England, and which it is to be hoped will before long find general application in our own country.

A great obstacle to improvement in railroad transportation arises from the great variety of designs prevailing in the rolling stock and other appurtenances of railroads, and it would contribute greatly to safety and economy if uniformity in these respects could be attained.

If all or a considerable number of railroad companies would combine to establish, at common expense, a station where experiments and tests as to the value of railroad plant, rolling stock, and appliances could be made on a large scale, and under the direction of scientific and practical men, it would save them the expense of individual efforts, and secure much more trustworthy results.

As an instance in which the railroad companies have perceived the benefits arising from uniformity, I may mention the change of gauge from 5 feet to the standard, lately made on the Southern roads. Between May 31 and June 3 of this year the gauge on 11,500 miles of road was changed with perfect success, and with hardly any interruption of traffic.

A great advance in the construction of mountain roads has been made by Abt, whose system has been successfully applied on the Hartz Railway.

Ship railways have heretofore been used for transporting small vessels, but it was reserved for a member of this society to work out the details of the problem of applying railroads to the transportation of the largest sea-going vessels long distances overland, in a manner which is fully indorsed by a number of the most eminent engineers and naval constructors.

The construction of the Chignecto Ship Railroad, from the Gulf of St. Lawrence to the Bay of Fundy, similar in its details to those proposed for Tehuantepec, is now under contract, and the project of a ship railroad across the Peninsula of Florida is being discussed.

The system of elevated railways is remarkably successful in the city of New York, and is being extended to the suburban districts north of the city. There are also similar lines in operation, or in progress of construction, in Brooklyn and Kansas City.

Cable tramways were first used in San Francisco in the year 1873; in New Zealand, 1880; Chicago, 1882; London, England, 1884; Melbourne, Philadelphia, and Kansas City, in 1885; and during the present year in New York and St. Louis. For short lines this system has many advantages, but for long lines the use of some other motor will probably be found more economical.

Electricity has for several years been in use for operating city and suburban tramways. There are different methods of carrying the electric current from the central station to the cars. In almost every case a separate conductor is used, either overground, as at Berlin, Baltimore, and the Giant's Causeway, or in slotted conduits similar to those used on cable tramways, but of smaller dimensions, as at Cleveland and on the Blackpool line. Electric tramways have been tested during the year, or are now in process of construction, at Toronto, Can.; New Orleans, La.; Minneapolis, Minn.; Detroit, Mich., Montgomery, Ala.; Denver, Colo.; and Appleton, Wis.

Different from these systems is that of Reckenzaun, who carries the electricity for operating the motor along with the car in a storage battery. This system is now being tried at Battersea, England. If storage batteries can be constructed which, besides being light and durable, will return a fair percentage of the power used in charging them, this system would give promise of great economy and convenience.

The rapid development of the application of electricity to many of the necessities and comforts of civilized life would seem to demand that more attention than heretofore should, by the profession at large, be paid to this branch of engineering. A knowledge of this science will, within a few years, be just as necessary to the civil engineer as is to-day the knowledge of hydraulics.

The building of inland canals has on this continent nearly ceased, as railroad transportation, although more expensive, insures greater regularity and dispatch, and is not subject to stoppage during winter, as are our Northern canals. Canal work is now almost entirely confined to deepening and widening the existing lines. The Welland and the Erie Canals are being thus treated. The locks of the Sault St. Marie Canal

have been deepened so as to admit vessels of ten feet draught.

But while the construction of inland canals is now at a standstill, a number of ship canals are in progress or projected. The most important of these, the Panama Canal, is, according to latest advices, not making such progress as to satisfy the friends of the enterprise. Indeed, it would appear that, if completed at all, it may have to be changed into a canal with locks.

The canal across the Isthmus of Corinth is in progress.

Among projects for ship canals which are reasonably certain of being carried out in the near future is the canal between the Baltic and the North Sea, and the Manchester Canal in England. Canals are also proposed from the Baltic to the White Sea *via* Lake Onega, and across the Isthmus of Nicaragua.

These engineering works, if completed, cannot fail to exercise a very beneficial influence on the commerce of the world.

The subject of irrigation is of the utmost importance to some of our States and Territories, and a large amount of this class of engineering work has been done in California, Arizona, Colorado, Dakota, Montana, Idaho, Oregon, and Georgia. The total length of ditches, pipes, and flumes is estimated at over 10,000 miles. The greatest progress in regulating the collection and distribution of water for purposes of irrigation has been made in Colorado, and the wise laws enacted by that State are considered and used as models by other States.

From the excellent report of the State Engineer of Colorado, it appears that there are over twenty-six water districts in existence in the State, distributing over 1,800,000 cubic feet of water per minute for purposes of irrigation. The number of acres irrigated in this State exceeds 1,400,000. An irrigating canal, 30 miles in length, is now under construction at Catlin, Colorado.

The extent and cost of some irrigating works is shown by the canal in San Joaquin Valley in Merced County, California. This canal is about half completed, and will, when finished, have a total length of 35 miles. It will pass through two tunnels, one 1,600 feet, the other 6,000 feet in length. The total cost of the work is expected to be $1,500,000.

A still larger irrigating canal is being excavated in Northern Wyoming, and will be more than 100 miles in length.

The improvement of our rivers, and more particularly of the Mississippi River, in which one-third of the population of the United States is directly interested, has made but little progress during the past year, owing to the failure of Congress to make the necessary appropriations. A costly plant of steamboats, barges, pile-drivers, etc., has been prepared for the prosecution of this work. Not only does all this plant remain unused, but the works already begun, which avowedly had been constructed rather light for the purpose they were intended to serve, are gradually giving way under the attacks of the river, and before long, if not cared for, will altogether disappear. This making appropriations sufficient to start work one year, and refusing next year even the money necessary to secure and complete what has already been commenced, is certainly the height of folly, and it is to be hoped that Congress, when arriving at a full understanding of the effects of such action, will not hesitate to change it. The completion of the Davis Island Dam on the Ohio River during the year marks a very decided forward step in the improvement of that river.

The storage reservoirs which have been constructed on the Mississippi River, 300 to 500 miles above St. Paul, with a view to regulating the flow of water in the river, were opened on the 1st of August, 1885, and have so far fulfilled all reasonable expectations as to their effect, and it is probable that these results, achieved with a comparatively small outlay of money, will encourage the authorities to further steps in this direction.

In the field of military engineering, complete success has crowned Gruson's efforts to construct shields and cupolas of chilled cast iron. Experiments have been prosecuted in torpedo construction and service, and also in the firing of shells filled with nitro-glycerine, which are said to have been successful. In addition to the foregoing, the Maxim machine gun, operated by the recoil, is a very important recent invention in gunnery.

It is greatly to be hoped that Congress will before long see the necessity of providing for our sea-coast defenses. When this is done, the present number in the Corps of Engineers of the United States Army would hardly suffice to plan and construct these works, and they would then be fully employed in the sphere of military engineering proper, leaving the improvement of rivers and harbors, and of all works of a civil character, to civil engineers. This would be the most natural and easy solution of the question now under discussion between members of the profession as to the proper policy of conducting public works. While it is my opinion that public works of a civil character could as well be carried on by civil engineers, appointed under strict application of civil service rules specially adapted to the purpose, I am opposed to any action by our society which might seem to be directed against the interests, or even privileges, of a number of our members, who are second to none in scientific attainments, in experience, and in character.

Tunneling nowadays can be done much more expeditiously and cheaply than formerly, in consequence of the improvement in drills and in explosives, coupled with better methods of ventilation.

Of large tunnels recently opened to traffic may be named those of the Severn and the Mersey.

The construction of the Cascade tunnel on the line of the Northern Pacific Railway has been commenced. It will be 9,850 feet in length, and next to the Hoosac the longest railroad tunnel in America.

Projects are on foot for several new Alpine tunnels; among them a tunnel under Mont Blanc, to be 12 miles in length, and one under the Simplon, to be 12½ miles long. But a prediction has been made, based on the experience gained in other Alpine tunnels, that the heat in the central portion of the Simplon tunnel would prove so great as to make human life impossible.

A project for a tunnel under Northumberland Straits, between Capes Traverse and Tormantine, deserves to be mentioned, as it proposes some bold and novel features of construction, and yet seems to be well considered in all its details, and to give fair promise of success.

The project of a tunnel under the Straits of Dover, according to late information, has a fair prospect of being revived. It is very desirable that a work which will confer such great benefits on the two countries which it is to unite should be completed; particularly since the work already done has made it a certainty not only that the construction of the tunnel is practicable, but that it can be completed in a shorter time and for less money than was originally estimated.

By far the largest work of subaqueous tunneling, for the purpose of removing rock impeding navigation, was that of Flood Rock, in Hell Gate. The area over which the work extended comprised nine acres. By the final explosion of October 10, 1885 (in which 235,000 pounds of rackarock and 75,000 pounds of dynamite were used), a quantity of rock estimated at 200,000 cubic yards was shattered so as to admit of ready removal by dredging.

The greatest activity in any branch of civil engineering during the past year seems to have prevailed in bridge construction. Quite a number of important bridges have been completed, among them that across the Susquehanna River, on the Baltimore and Ohio Railroad, 6,315 feet in length, having four spans of 480 feet and one of 520 feet; the Henderson Bridge across the Ohio River, 3,000 feet in length, with one span of 525 feet; the St. John's River Cantilever, 447 feet between piers; and the bridge across the Big Black River. Of large bridges in course of construction, the most important are the Forth Bridge, with two spans of 1,700 feet each; the Sukkur Bridge, across the Indus, having a span of 790 feet; and the Lachine Bridge, on the Canadian Pacific Railroad, with two spans of 408 feet.

The contract for the erection of a bridge at Hawkesbury, New South Wales, has lately been awarded to one of our American bridge companies, a very gratifying fact when it is considered that the contract was obtained in competition with various bridge companies of England and France. The main difficulty to be overcome in the construction of this bridge lies in its deep foundations, which are to be sunk to a depth of 170 feet below the surface of the water.

The extremely low price of iron and steel greatly favors the selection of long spans for bridges, as the saving in piers and foundations balances the extra cost per lineal foot of long spans.

The tendency among bridge engineers at present seems to be favorable to the selection of systems in which the strains to which any member may be subjected can be accurately determined by calculation; and the use of the pin joint, which may be called a distinctive feature of American bridge construction, favors the attainment of this object. The rapidity with which bridges with pin joints can be erected is an immense advantage, particularly when material for such bridges has to be prepared at a great distance from its final destination, or when erection must take place where no facilities for doing iron work exist. This system of construction is therefore particularly adapted for new and thinly settled countries.

Since the great success of the cantilever bridge at Niagara Falls, a number of other bridges have been built on this principle. Indeed, by far the greater number of long span bridges lately proposed are to be cantilevers, as this system offers great advantages in erection. But they are subject to greater deflections than those built on other systems, and I believe that the arch might, in many cases, be preferable, as it gives almost the same facilities in erection, and is less deflected under the action of a moving load. I am glad to see the arch proposed in a late design for the Harlem River Bridge.

As I have before mentioned, both the weight of locomotives and of cars has greatly increased of late, and bridges constructed years ago, of sufficient strength to carry the load which at the time of their erection was considered a possible maximum, are now, by the increase in the weight of rolling stock, subjected to loads which greatly reduce their factors of safety. There are undoubtedly a great many of the older bridges which require to be strengthened or replaced if accidents are to be avoided.

I think it is the duty of the members of the profession to direct the attention of State governments to this fact, and to suggest that thorough examination of all bridges be made. This would be a work of considerable magnitude, and would require both time and money, but in a civilized commonwealth the care for the safety of the citizens should outweigh any financial considerations.

The necessity of tests and experiments when new forms or new materials are to be introduced will be readily admitted. To make such tests, not on small models, as at one time was considered sufficient, but on full-sized members, as has been shown to be preferable, requires large testing machines and plenty of both time and money. No individual engineer, and but few corporations, can afford to provide the necessary funds for this purpose. It was therefore proper that for the advancement of science, as well as for the benefit of the material interests of the whole country, the United States Government should cause a testing machine of large dimensions to be built, which, under proper regulations, would be accessible to engineers and manufacturers for tests of material.

Such a machine was erected at Watertown, Mass., has been in use for several years, and has proved of very great service; yet, being under the immediate control of the Ordnance Department of the United States Army, it is, during a great portion of the time, necessarily employed in the service of that department; and as a great many of the specimens tested are of small dimensions, the experiments made thereon are not of any value to the general public, and the primary object for which the construction of this machine was undertaken is partly defeated. A remedy would be found if the United States Government could be induced to erect, in addition to this large testing machine, some machines of smaller dimensions, and at the same time to appropriate an amount sufficient to pay for tests not of special, but of general, interest, and for the time of engineers specially charged with the work.

While on the subject of tests, I may mention that during the past year there have been made public the results of a number of valuable experiments made by members of this society on cements; on the comparative value of lubricants; on evaporation; on the strength, elasticity, etc., of iron and steel; and on other matters of interest to the profession.

The use of the new system of notation of time is gradually extending, and promises to become universal in application. The introduction of the metric system is also progressing, though not quite so rapidly as might have been expected from the progressive spirit of our nation. It seems strange that in this age of rapid interchange of goods and thoughts between civilized nations, such an obstacle as the use of different measures in different parts of the globe should be allowed to exist. Nobody can doubt that this obstacle will be removed before long, and the only question can be, What system should be adopted?

There are now 242,000,000 of people using the metric system, and the weight of numbers is probably already on the side of that system. This may be balanced, or even outweighed, by the industrial prominence of the nations which use the English standard; but the selection should clearly not be made either on the basis of the greater number now using a particular system, nor on the cost of the change in money or in temporary inconvenience, but it should be made on the intrinsic merits of the system. And there can be no doubt that the metric system fulfills almost every condition of a perfect system of measurement, and could hardly be improved.

Among the strong objections to the introduction of the metric system has been the necessity which it involves of a partial remodeling of the tools in our workshops. This would undoubtedly be very serious, but the saving in time to all classes who are engaged in any kind of business requiring measurement and calculation (and there are but few which do not require them) would soon make up for this loss. As to the inconvenience resulting from its introduction in the ordinary walks of life, it will, judging from the experience of Germany, hardly be felt in a country in which education is so universally distributed and the mental activity of the people so strongly developed as in our own. But even our manufacturers may be willing to agree to the change when they consider that many countries showing rapid progress, such as Brazil, Mexico, and the republics of South America, have adopted the metric system, and that this gives to France and Germany a great advantage over the United States in selling to these countries their manufactures.

I am glad to be able to state that a bill has been introduced in Congress which prescribes that, after the 4th day of March, 1892, the metric system shall be exclusively used in all transactions in which the Federal Government is concerned.

I may congratulate you upon the rapid growth of the society, both in numbers and influence, but it is yet far behind the Institution of Civil Engineers of England as to numbers, and probably even more so as regards influence. This is mainly due to the fact that English capital has been largely employed in the English colonies, and in foreign countries, in enterprises managed by English engineers; while our capital and the services of our own engineers were, until lately, almost exclusively needed at home; and to the further fact that the English people hold the profession which produced some of their greatest men, such as Watt, Smeaton, and Stephenson, in higher esteem than has been the wont of our own fellow countrymen.

But our country is getting both richer and wiser every day, and I hope the time is near at hand when American engineers will attain a wider sphere of action and a higher degree of public esteem. Those of us who have seen engineering, as a profession, start into life in the United States, may not see that hope realized, but we have the satisfaction of knowing that we have earnestly striven for the attainment of this end.—*Trans. Am. Soc. C. E.*

AILSA CRAIG FOG SIGNAL MACHINERY.

AILSA CRAIG, the well-known rock island in the Firth of Clyde, has always been a source of danger to shipping entering and leaving the Clyde, and has been the cause of innumerable wrecks. In order to guard the mariner against its risks, the Commissioners of Northern Lights have lately erected upon it a lighthouse, together with a fog signaling installation of a novel character and on a very extensive scale. This new plant was officially opened on July 17, and will be found to possess much interest.

The difficulties connected with the establishment of efficient "siren" fog signals at this station, says *Engineering*, were considerable, as the conditions of the situation were totally different from those which usually obtain at lighthouses and lightships. The rock rises to a height of 1,140 ft., and its precipitous form rendered it necessary that there should be two signals in order that the warning should be heard and understood by vessels on both sides. These signals are situated one on the north and one on the south side of the island. The distance between them is about 1¼ miles, and the length of pipes for conveying the compressed air for operating the sirens is about two miles.

A plan for these signals was submitted to Messrs. Stevenson, the engineers to the Northern Lighthouse Board, but the Board of Trade declined to sanction the expenditure of public funds upon the work, unless it could be conclusively proved that compressed air, at a high pressure, could be conveyed and signals automatically operated at such great distances. A full-sized experiment was consequently proposed and carried out at Pladda Island, under the direction of Mr. Charles Ingrey, who, after surrounding this island with pipes, was able to satisfactorily demonstrate the practicability of his system of long distance signaling.

The construction of the works at Ailsa Craig has occupied upward of three years, this length of time being necessary on account of the difficulties presented by the rock itself, through which a track had to be cut for the pipes to be laid in. The rock, a close-grained granite, is exceedingly hard, and required considerable blasting operations, and in several places light lattice iron girders have had to be erected to carry the pipes across chasms and openings in the rocks. The size of pipe used in the conveyance of the air from the compressing machinery to the signal houses is 2½ in. internal diameter, and the pressure of air 80 lb. per square inch. At several points where there is a depression in the pipes, siphon boxes have been placed for the purpose of allowing any accumulation of water to be blown out.

IMPROVED FOG SIGNALING MACHINERY.

The trumpet houses are formed of concrete, and are of very massive dimensions, as in the positions in which they are placed great strength is requisite to resist the action of falling rocks and the extraordinary force of the wind. In each of the trumpet houses is a wrought-iron air receiver of about 150 cubic feet capacity; the upper part of the receiver carries the Holmes siren and copper trumpet, with the necessary starting valves, and the lower part the automatic apparatus for operating the signals. The general arrangement is shown in Fig. 1, the scale of the trumpet houses and lighthouse buildings being, of course, out of proportion to the size of the rock.

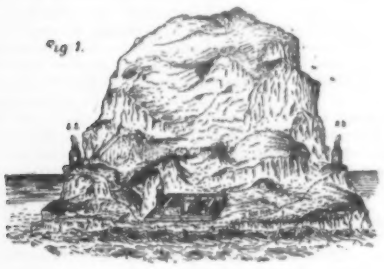


Fig. 1.

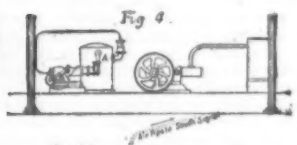


Fig. 4.

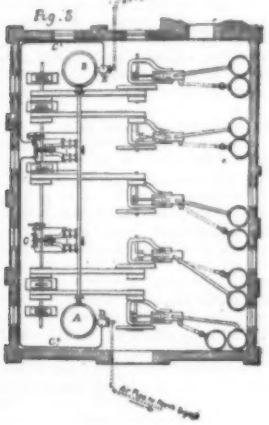


Fig. 5.

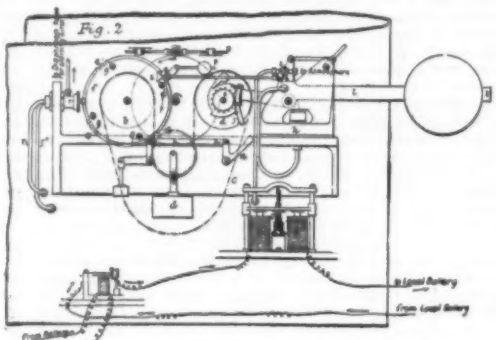


Fig. 2.

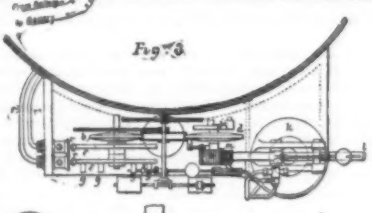


Fig. 3.

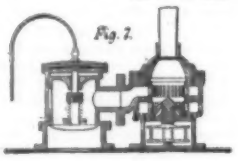


Fig. 7.

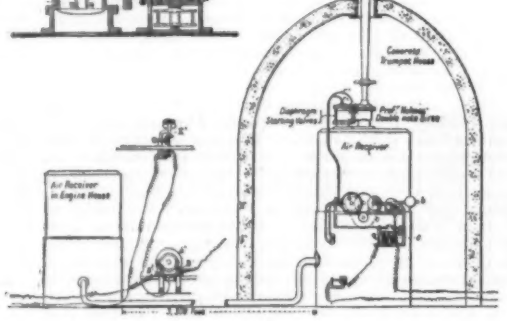


Fig. 6.

The south signal consists of a double note siren, giving successively a high note and a low note, the former corresponding to 640 vibrations per second, and the latter to 280. The signal is as follows:

High note, 2 secs.; silence, 2 secs.; low note, 2 secs.; silence, 2 secs.; high note, 2 secs.; silence, 170 secs. = 180 secs. or 3 min.

The north signal consists of a single note siren giving a high note of 640 vibrations per second. The signal is as follows: High note, five seconds: silence, 175 seconds, equal to three minutes. The signals are so timed that the north sounds exactly ninety seconds after the south has ceased.

The air for operating the sirens is compressed by air pumps having four cylinders 10 in. in diameter and 18 in. stroke, the power being given by 8 horse power gas engines, of which there are five—four being used—the other remaining as a reserve. The gas is manufactured from crude oil in a small gas works erected for the purpose.

Figs. 4 and 5 show a plan and elevation of the engine house and the arrangement of the machinery. The compressed air is forced into the air receivers, AB, in connection with which are the pipes leading to the north and south respectively. The length of piping not being equal, and one signal requiring a larger volume of air than the other, provision has been made for transmitting automatically the necessary quantity. A camwheel, C, makes a complete revolution every three minutes, and by means of a cam path, opens one or the other of two small valves which communicate by small copper pipes, c^1 c^2, with diaphragm valves, D E, on the receivers, the length of time either of these valves is kept open regulating the volume of air to be transmitted north or south, as the case may be.

The automatic apparatus in the trumpet house is particularly ingenious and interesting, and as it is one of the chief characteristics of the whole arrangement, we have illustrated it fully, and will give a short description of its operation. (Figs. 2 and 3.)

As before mentioned, one signal consists of a single blast, and the other of two blasts of high note and one blast of low note, each signal being given every three minutes, but the one exactly intermediate with the other. The automatic apparatus are substantially identical, and the description of the one will apply to the other, except that the arrangement of valve opening device is somewhat different.

The apparatus consists essentially of two chain wheels, *a*, *b*, which carry an endless chain, *c*, and support a weight, *d*. Upon the spindle of the chain wheel, *a*, is a pinion, *e*, and on the spindle of the chain wheel, *b*, is a pair of cam wheels, *f*; the former is prevented from being turned by the weight by reason of the ratchet and pawl, *j*, and the latter by reason of one or the other of four pins, *g*, resting on the end of a bolt, *h*.

When the compressed air which is being sent from the engine house reaches a given pressure in the receiver, the pressure, acting upon a diaphragm and piston, *k*, overcomes the resistance of the weighted lever, *l*, and causes the toothed quadrant, *m*, to turn the chain wheel, *a*, thereby raising the weight, *d*. The quadrant, continuing its motion, strikes a bell crank, *n*, and withdraws the bolt, *g*, from contact with the pin, *g*. The chain wheel, *b*, is therefore free to revolve by the falling of the weight; the chain wheel, *a*, is retained by the pawl and ratchet, *j*. A train of wheels operates a vane or flier, *p*, so that the revolution of the cam wheel, *f*, is retarded and the time regulated.

While the wheel is revolving, the projections, *q*, come in contact with small valves, *r*, and, opening communication with the receiver, allow compressed air to pass by the copper pipes, r^1 or r^2, to the starting valves of the siren. The length of time of the sounding and the intervals between each note is governed by the width of and spaces between the projections.

Before the wheel, *b*, has completed its partial revolution, one of the pins, *g*, comes in contact with the end of a rod, *s*, which, by operating a three-way cock, *t*, allows the air from the diaphragm, *k*, to escape to the atmosphere, so that the weighted lever falls to its normal position, and the bolt, *g*, stops the wheel, *b*, from further movement. This operation is repeated every three minutes with the utmost regularity.

It should be mentioned that the signals are always ready for starting at any moment in case of sudden fog, and that beyond occasional visits for cleaning purposes, no attendance is necessary at the trumpet houses, which are situated at far distant and isolated parts of the island.

As a safeguard and means of securing certainty of action, an electric arrangement is used in connection with the apparatus. The cam wheel, A^1, in the engine house operates every 1½ minutes one or the other of two electric switches, B^1B^2, and sends a current to the north or south trumpet house. An electric magnet, C^1, depresses a small valve, D^1, and allows air from the receiver to pass to the diaphragm, *k*, at the right period, and to escape after the weighted lever, *d*, has done its work.

We have, on previous occasions, referred to the Professor Holmes double note siren, so that a description of this now well-known apparatus is not necessary, but we illustrate it in section, and also show the arrangement of diaphragm starting valve.

The Ailsa Craig signals are at present the only instance of long distance signaling, and the great success which has attended this installation would seem to point to a very extended application of the system, as there are numberless places where fog signals are urgently required, but where it would be impossible to erect engine houses and machinery.

The inventor claims by his system to be able to work fog signals when situated at several miles distance from the spot where the power is generated.

The work has been designed and carried out under the personal superintendence of Mr. Charles Ingrey, C.E., of 49 Queen Victoria Street. The contractors are the Pulsometer Engineering Company, London, who are the proprietors and manufacturers of the patent siren.

HOUSING FOR SHIPS' BOATS.

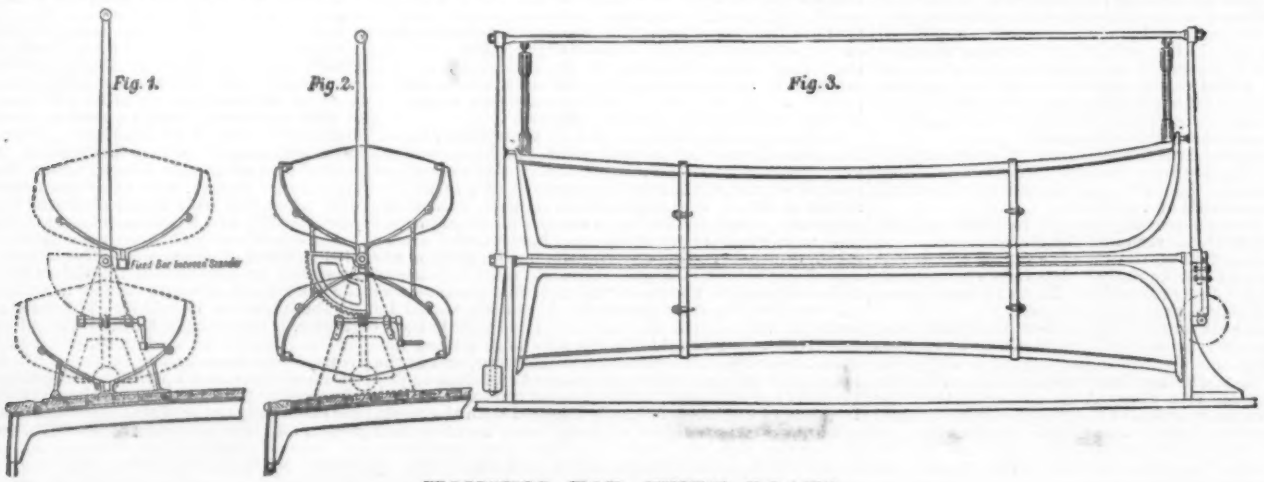
WE illustrate below a new and ingenious arrangement for the "housing" of ships' boats, by which it is made possible to double the number of boats carried, without taking up any additional deck space or providing extra davits. The arrangement in question is a combination of boats' chocks and davits, as shown in Figs. 1 and 2. An iron framework is provided, at each end of which there is a davit worked by means of a worm and wormwheel quadrant. The davit is brought into the horizontal position when the boat is being lowered. After the upper boat is clear, the davit is brought back to the vertical position, and is then ready for the lower boat.

In the arrangement shown in Fig. 1, the boats are housed as usual, with the gunwales up, and this is applicable to all vessels with a flush deck or bridge. The other arrangement is applicable to vessels having fixed bulwarks, and consists of an iron longitudinal bar swiveling or fixed at the ends to metal standards. When the upper boat is lifted clear and lowered over the ship's side, the lower one is swiveled up into the top berth, and is then ready for lifting and lowering in its turn.

It will be observed, says *Engineering*, that by this arrangement there will be no difficulty in doubling the number of boats, at no expense beyond that of the extra boats carried; and as each lifebelt costs from 7s. 6d. to 10s., there would be a saving nearly equal to the cost of the boats, as there would not be the same necessity for carrying lifebelts when the boat accommodation is made so ample.

In cargo vessels, where the decks are so much broken up with hatches, and where it is often a difficult matter to find room for the boats, the same number can be carried in half the space usually occupied in that way, and at a saving in respect to davits, guys, blocks, etc.

This boat-housing arrangement has been devised and patented by Mr. J. P. Wilson, general manager to



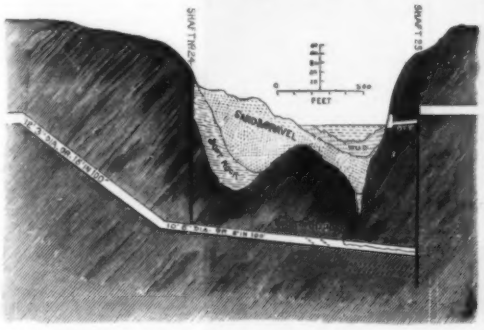
HOUSING FOR SHIPS' BOATS.

Messrs. James & George Thomson, Clydebank Shipyard, near Glasgow, and a model of it is shown in the Liverpool Exhibition by Messrs. Mechan & Sons.

[Continued from SUPPLEMENT, No. 558, page 8909.]

THE GREAT AQUEDUCT, NEW YORK CITY.

PERHAPS the most interesting and novel feature of the great aqueduct now being built by the city of New York to increase its water supply is that portion of the tunnel extending beneath the Harlem River. The contrast between the old and the new methods of crossing this river has been happily brought out by our artist in the engraving. High Bridge, over which



LONGITUDINAL SECTION, AQUEDUCT UNDER HARLEM RIVER.

the present supply comes, shows plainly in the background; the foreground being occupied by the section through the bed and banks of the river, far below the surface of which the new aqueduct is to pass.

We here have, within a half mile, the two most wonderful examples of conducting water across a river—one forming the most conspicuous and attractive object in a naturally beautiful region; the other forming the safer conveyer, far beyond the reach of any efforts that might be made to destroy it, and as durable as the solid rock in which it is buried.

The bed of the river is composed of sand and gravel at the eastern side, and mud at the western side; below these is hard rock, which takes the form, immediately under the mud, of a sort of deep, narrow valley, as shown in the accompanying longitudinal section To clear this low spot, the aqueduct must be sunk at least 150 ft. below the river water level, when the crossing can be made through solid rock. After reaching the bottom of shaft No. 25, during construction, a small test drift will be extended to the doubtful rock; if this shows hard rock, the tunnel will be erected as indicated by the full lines; but if it uncovers loose rock, the shaft will be further extended, and the tunnel built as indicated by the dotted lines.

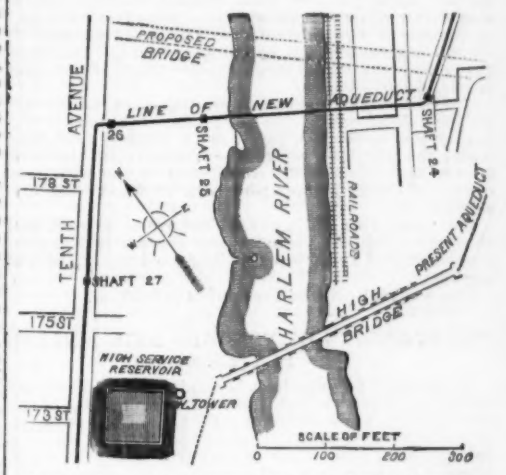
Section 12 of the aqueduct extends from a point in the vicinity of shaft 24 (shown in a map published, together with a general description of the aqueduct, in the SCIENTIFIC AMERICAN of November 7, 1885), on the easterly side of the Harlem River, across and under the river to a point near 178th Street and Tenth Avenue, a total distance of about 1,937 feet. A short distance east of the river the aqueduct is carried downward on a grade of 15 in the 100, the diameter being 12 feet 3 inches to a point just east of shaft 24; from here to shaft 25, on the opposite side of the Harlem, the grade is 2 in the 100, and the diameter 10 feet 6 inches.

The water on its way to the city will then flow up shaft 25 to a point above the surface of the river—at a level about equal to that of the aqueduct at the opposite side before it dips to pass under the bed of the river—and from thence through solid rock to a gate house at 135th street, between Convent and Tenth Avenues, the diameter of the last mentioned portion being 12 ft. 3 in. This section of the aqueduct is to be lined with masonry throughout, and that portion below the river is to be lined with cast iron to prevent percolation. Where the aqueduct has a diameter of 12 ft. 3 in., the cross section of the excavation is to be a circle 14 ft. 11 in. in diameter; where it is 10 ft. 6 in. in diameter, the circular section of the excavation is to be 13 ft. 10 in. in diameter. The test drift is to have a rectangular section 7 ft. wide by 6 ft. high, and the blow-off tunnel to be excavated between shaft 25 and the river, above high-water mark, for the accommodation of two blow-off pipes, is to be 12 ft. wide by 6 ft. high. The lining is to be of brick, backed up with concrete and rubble stone, and all the masonry is to be laid in hydraulic cement mortar, all of which will be subjected to severe tests before being accepted. All the mortar is to consist of 1 part of cement to 2 parts of clean sharp sand, and the broken stone for the concrete is not to exceed 2 in. in greatest diameter.

The excavation for the double shaft 25 is to be 38 ft. wide, across the line of the aqueduct, by 16 ft. 6 in. long, and is to contain two masonry wells, each 12 ft. 3 in. in diameter, and a drain pipe 36 in. in diameter. The cast iron lining for the wells is to have a tensile strength of at least 16,000 pounds per square inch, is to be 1¼ in. thick, and each ring, at least 5 ft. high, is to be cast complete or in four or more segmental pieces.

One of these wells will unite the aqueduct under the Harlem with that leading to the city, while the other will extend a short distance below the first to form a sump, and is designed to be used as a pump shaft, a gate forming a passage between the lower ends of the two wells. From the top of each shaft, near the top, a blow-off pipe 4 ft. in diameter will lead to a chamber built in the face of the bluff just above the river level, and each pipe at its end will be provided with a valve.

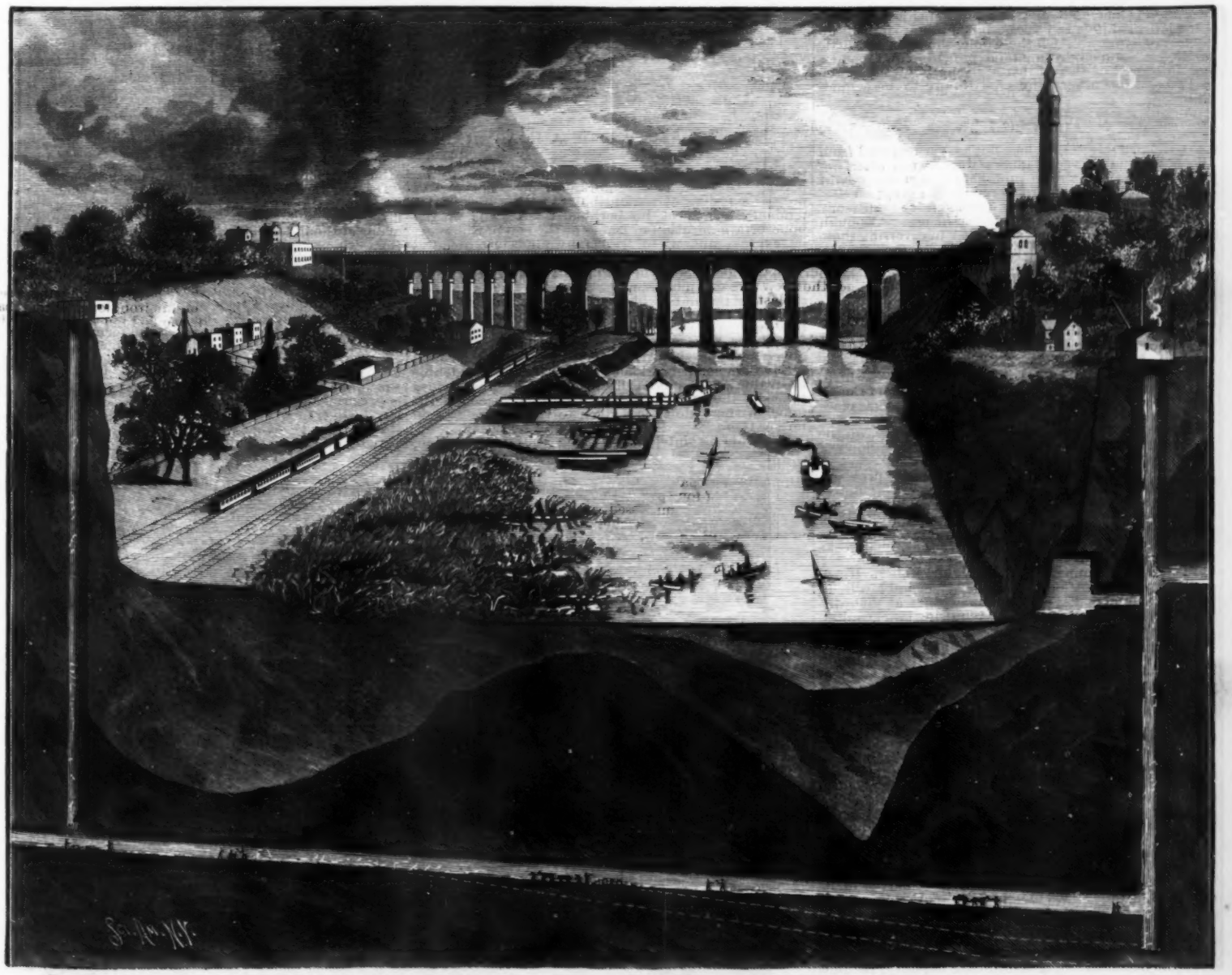
The pump shaft will only be used when it is necessary to remove the water from the tunnel to make in-



MAP OF AQUEDUCT AT HARLEM RIVER.

spections or repairs. The water will then be pumped out by means of an ordinary hoisting engine operating an iron cylinder 4 feet in diameter by 15 feet in length. This cylinder or bucket will be lowered into the pump well, when it will fill with water through a butterfly valve in its bottom; when raised, a valve in the side of the bucket will be tripped automatically, and the contents—about 1,500 gallons—will be discharged into the blow-off pipe leading to the Harlem. Of course, the bucket each time needs only to be lowered far enough into the well to fill. As the pump shaft extends below the other, the complete emptying of the tunnel can be easily effected.

Wherever considered necessary, the aqueduct under the river will be lined with cast iron, 1 inch in thickness. This lining will be made up of rings, 2½ feet long, in the direction of the tunnel, and each ring will be composed of four segments, put together by means



THE NEW AQUEDUCT PASSING UNDER THE HARLEM RIVER, NEW YORK CITY.

of bolted flanges. The joints will be made of lead, 2 inches wide and one-sixteenth of an inch thick. The side and flanges are to be accurately faced, and the holes through the flanges are to be drilled to templets, so that all pieces will be interchangeable. Extreme care will be exercised when putting these lining pieces together to make every joint watertight, and after each ring has been put up and fastened to the one already in, the masonry will be built around the iron until it completely fills up all the space between the lining and the inside of the excavation. The great pressure to which this section will be subjected makes necessary the taking of unusual care to insure work of the most perfect description.

The draining of the tunnel during construction will be by a drain cut in the rock below the floor of the excavation to such a depth as to entirely free from water the portions where the masonry of the floor is to be laid. Before the completion of the work, the drains, of vitrified sewer pipe, will be filled with masonry.

Compressed air drilling machines are to be used, and the work of blasting is to be done cautiously, so as not to endanger the roof by exploding too large charges of explosive.

The contract price of the section is $430,000.

THE STRENGTH OF PUNCHED AND DRILLED PLATES.

ACCORDING to experiments conducted by Professor Tetmajer, of Zurich, upon Low Moor iron plates of the best quality, to ascertain the effect upon the strength of materials of drilling and punching holes in them, a wrought-iron plate is not of uniform strength everywhere. It is strongest in the middle, decreasing equally toward the two edges; but the difference is partially, and sometimes wholly, obliterated by the method of making holes in it. Punching diminishes strength; the loss increasing with the increasing size of the hole. With a hole equal in diameter to the thickness of the plate, the loss amounts to about 20 per cent. of the strength of the original plate. The loss may be diminished or obviated by annealing a punched plate when the size of the hole is 1·5 times the thickness of the plate. If the ratio is greater than 1·5, the original strength cannot be regained by annealing; and if less than 1·5, the strength may be increased. The greatest increase in the strength of a punched plate by annealing may be 17 per cent. of the original strength of the plate. The original strength of punched plates may be partly or wholly regained by reamering the holes until all trace of the punch is removed. When the punch-mark is completely reamered out, the strength of the material may be increased 8 per cent. With drilled holes there is no loss of strength if the diameter of the hole is equal to, or greater than, the thickness of the plate. By drilling and annealing, the original strength of a plate is increased an average of 10 per cent. Reamering a drilled hole is useless, but filing it slightly increases its strength. On the whole, there is very little difference between drilling, and punching and reamering, in respect of the ultimate strength of the material; but these observations only apply to best qualities.

COAL MINING.

ALTHOUGH electricity has not as yet removed from the eyes of miners that gloom that is too often reflected upon their spirits and makes them the prey of agitators, it has already rendered them a great service. In fact, it has permitted of increasing the efficiency of the various explosive substances in use. Although criminals have sometimes succeeded in diverting these valuable materials from their legitimate purpose, the catastrophes that they have prepared fall into insignificance before the immense results that the daily use of dynamite has effected, ever since it has been known how to handle it safely and on a large scale, and especially at the present time, when we are no longer ignorant of the art of increasing its effects tenfold by rendering the explosion of any number of cartridges perfectly instantaneous.

The carrying out of extensive public enterprises which, like those of the Mt. Cenis Tunnel, the Panama Canal, and the Channel Tunnel, assure our age of a place apart in history, is certainly due to the cheapness of the usual metals and of coal, that is to say, to the means of action that the mining industry permits of extracting from the bowels of the earth.

By way of compensation, the mechanical processes employed by great engineers for transporting motive power created upon the surface of the earth by means of compressed air or electricity, will permit of diminishing the amount of manual labor necessary for bringing to the surface those buried treasures that the Greeks and Romans would have regarded as inaccessible.

In "British Mining," a work by Mr. Robert Hunt, we find an illustration of a mine of several levels, in which the miners have drilling machines at their disposal. But such a plant as this, requiring large capital, cannot be seriously proposed at an epoch in which social catastrophes may be joined with natural calamities that engineers have already had to triumph over; and the engineering art, which is capable of mastering water, fire, and gas, cannot war against those tempests that rascally doctrines are stirring up in the credulous minds of workmen, and of which the latter are too often the first victims.

The peculiar advantage of using compressed air is that it brings with it the oxygen which the respiration needs, and that it contributes to lower the temperature, which is sometimes so elevated that the miners cannot keep on their clothes while at work. This mode of transporting power indirectly contributes, then, to a solution of the vital problem called airing, without which all the ores within our reach would have been long ago exhausted.

In fact, mankind, thanks to progress in ventilation, has not as yet met with an insuperable barrier in its conquest of the "black diamond." Mention is made of mines that have been opened under the ocean, and in which is heard a tremendous noise, such as would be produced at the bottom of the sea through rocks rolled and tossed about by the incessant action of the waves.

In the present state of the mining industry, perhaps the most frequent cause of catastrophe is the caving in of insufficiently stayed galleries. Of all the calamities that menace the miner, those due to these subsidences are certainly the most terrible. In fact, if the victim is not terribly crushed, he runs the risk of being buried beyond human aid in a dark cavity in which he will slowly perish through starvation.

Unfortunately, in most provisional galleries that are opened for the temporary needs of exploitation, it is necessary to sustain the earth with wooden stays, since one could not think of consolidating any but spacious galleries, intended to be permanent, with brick or stone masonry.

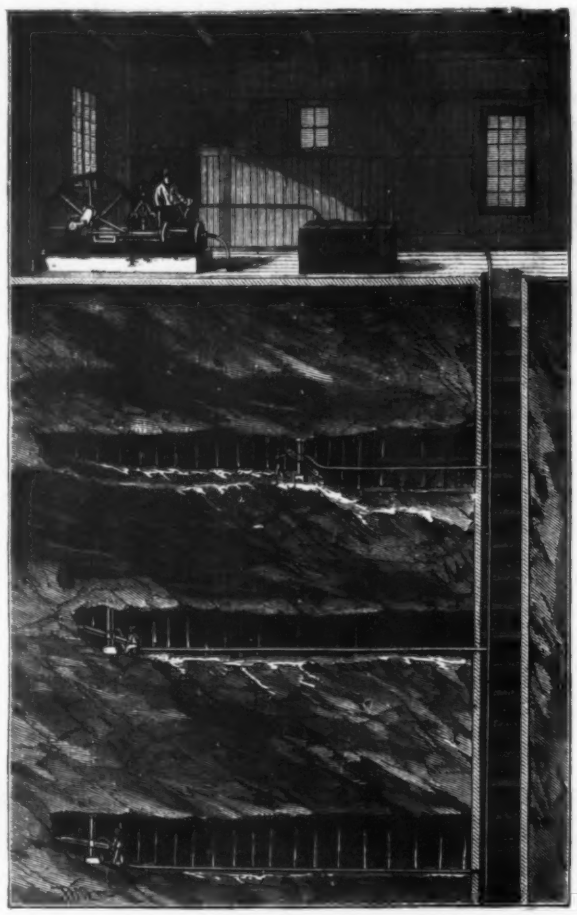
One of the greatest progresses to be effected, then, is to separate the service of extraction from that of timbering. In fact, as the workman does not always possess a feeling of responsibility, he has too great a tendency to neglect his personal safety; and, in the hope of a gain of a few francs at the end of the week, he exposes himself to frightful wounds or a dreadful death.

On another hand, the negligence of the collier is followed by the most deplorable results to the owner, since the peasants who own the surface are upon the watch for the least fissures, in order to mercilessly fleece the company, whom draconian laws put at their disposal. In fact, the barbarous legislation that still governs us provides that the owner of the land shall receive as a compensation an indemnity equal to double the value of his land or fixtures. Not even is account taken of the superior value that the presence of the mine in the vicinity has given to the real estate and houses there.

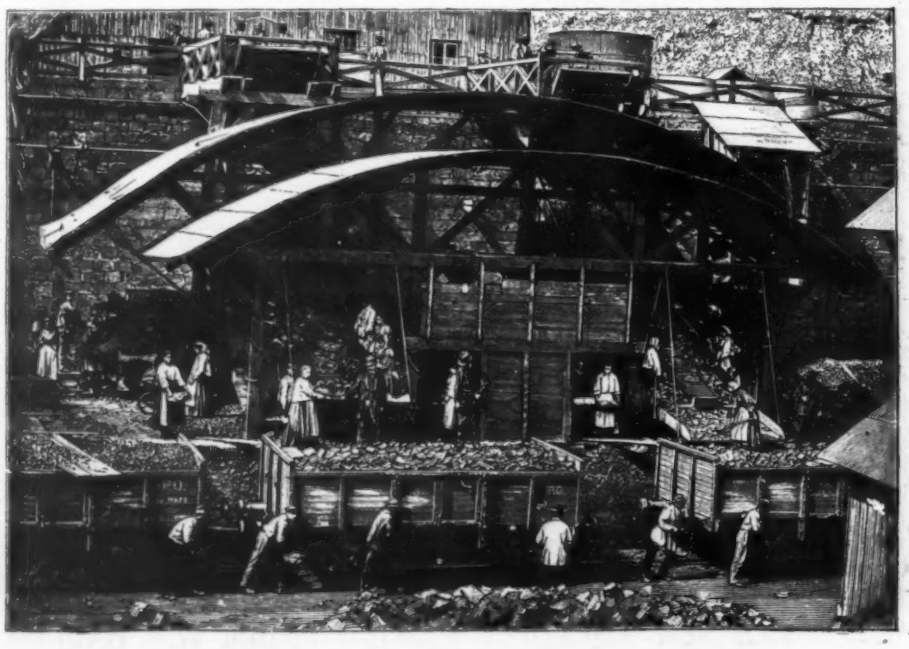
Without his intelligence rising to this conception, the miner makes himself the accomplice of property right in its most rigid expression. He does not perceive that his interests and those of his employers are interdependent. The interest that is hostile to his own by nature is that of the dealer, who tries to put him into a state of revolt against the laws of economy by making him refuse to join co-operative societies, like those that are so numerous among English miners, thanks to the efforts of Mr. F. O. Holyoake, the apostle of co-operation on the other side of the Channel.

It is thus that begun that conflict which will hereafter be celebrated in history under the name of the "Decazeville Strike," and the events of which it is not our province to relate in this place. Yet we cannot terminate our rapid sketch without giving a view of one of the industrial sites of this immense exploitation, which was started under exceptionally difficult circumstances, since subterranean fires came to add to the number of difficulties that the engineers had to fight in order to prevent the entire destruction of all the mineral riches of the district.

We have represented the place where the coal is sorted, and then placed upon cars for shipment by rail. The engraving that we give, which is from an excellent photograph, renders it unnecessary to enter into any explanation. We may state, however, that this operation of sorting, which is in nowise laborious, is performed by women, whom a very wise and humane law forbids to work within mines. The salary that they earn, without much fatigue, is very high as compared with that gained in farm work.—*La Nature.*



SECTION OF A COAL MINE, SHOWING LATERAL GALLERIES.

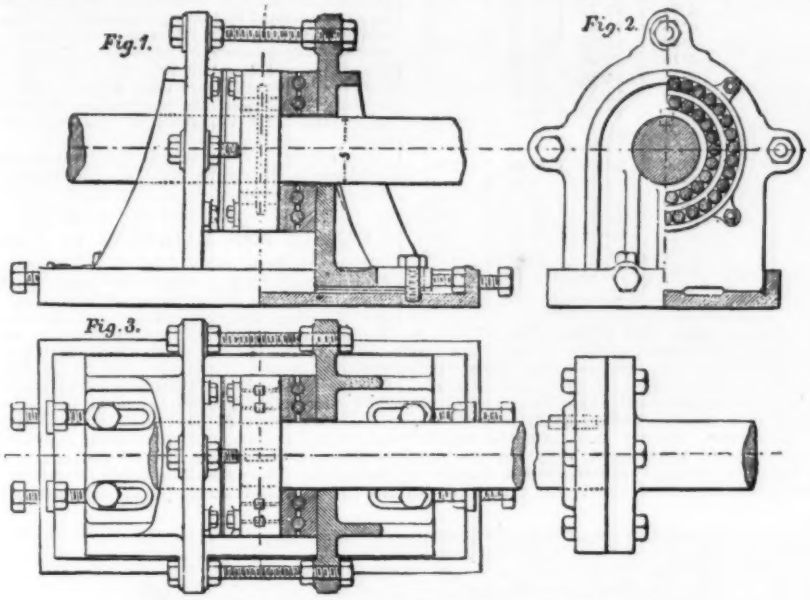


THE SORTING OF COAL AT DECAZEVILLE, FRANCE.

BALL THRUST BEARINGS.

THE application of ball bearings to bicycles and tricycles has proved so successful in reducing friction that it may be fairly assumed that there are many other purposes to which they might be applied with success. For eighteen months past they have been used in the thrust bearings of steamers, and under these circumstances have been found to effect a notable economy in the friction of the engine, allowing it to run with increased speed on the same consumption of fuel as was required with the ordinary bearing. A thrust bearing of this kind has been applied by Mr. L. B. Wells, of Highfield, Northwich, Cheshire, who has designed and patented the arrangement, to the steam launch Delamere, and gives very good results, the speed of the engines having risen from 177 to 187 revolutions per minute with the same boiler pressure and grade of expansion. A ball bearing has also been fitted to the steam tug Volunteer, which has an engine with a cylinder 22 in. in diameter, and this also continues to do its work very satisfactorily. The method of application to a 5 in. shaft is shown in the annexed engravings. There are two sets of bails, one for going ahead and the other for going astern. In each set there are two circles which run between grooved plates of Whitworth compressed steel. One plate is bolted to the thrust block, while the other abuts against a collar on the shaft. This collar is made in halves, and sits in a shallow groove turned into the shaft. It is held in place by having a ball path bolted to each side of it, the collar and the two paths thus forming a compact piece which cannot move endwise on the shaft, and is carried round by a key. In some cases, where the bearing is applied to an existing shaft, a taper cotter is put through the collar and shaft to secure the former.

It is claimed for the ball bearing that it requires very little oil, that it wears very slowly, and produces no end play in the shaft, and that its first cost is moderate.



BALL BEARING FOR SCREW SHAFTS.

HENNING'S TESTING APPARATUS.

A PAPER read recently at the American Mechanical Engineers' Society described two forms of testing apparatus invented by Mr. G. C. Henning, of New York. As these apparatus involve some novel features, the following description and illustrations will be of interest.

This machine is designed to measure very minute elongations of metals when subjected to stresses. It was decided that it would be desirable to use a different apparatus for long specimens than that used for short ones, since each had to fulfill totally different requirements, and to be equally accurate throughout the entire work; and, moreover, it must be so constructed that it could be checked at any time by the observer to prove its accuracy. Those shown to the writer had been in use in one instance for two years, and in the other for nineteen months.

The apparatus shown in Fig. 1 is the elevation of a self-centering electric contact micrometer, Fig. 2 being a plan of the same; A and B are two carrying rames surrounding the test piece, S, and free to move with any change of length in the direction of such change. The distance moved is measured by means of a pair of finely divided micrometer screws and heads, E, carried by one frame opposite a pair of contact plugs, G, carried by the other frame. To secure a perfectly symmetrical adjustment of this apparatus with reference to the axis of the test-piece, each frame has a pair of spring cushion platens, C, and a pair of centering screws, H, placed on opposite sides of the frames and exactly midway between the micrometers, and the vertical distance between the pair of screws in the two frames is fixed by means of the side bars, D, which swing around the shoulders on the frames and are made of any desirable length, 6 in. to 10 in. or more. In the figure these bars are shown in a position nearly vertical, merely to bring them into view. When the machine is in use, these bars rest on the lower crosshead of the testing machine or hang down in a vertical position, so as not to disturb the apparatus or affect its readings.

One side of each frame is hinged for convenience, but is so carefully fitted there is no play in the joints of the hinge, P, and when the frame is closed it is practically solid. Vertical scales, E, measure the amount of elongation, if greater than the pitch of the micrometer screw. Each of the frames is connected with the same electric bell, a circuit, WW, being established by bringing the point, F, of the micrometer in contact with the contact plug, which is insulated by a gutta-percha bushing, R, inserted in the upper frame. One wire is attached to the ends of the insulated plugs, which are connected with each other, and the other wire is attached to the lower frame.

To be able to adjust the apparatus to any size of specimen, each spring platen is provided with a stud bolt passing through the frame and a spring, and carrying a nut, N, between the two, so that each may act as a bearing for the nut when it is turned to increase or decrease the space between the opposite platens; to obtain a uniform adjustment, these platens are set so as to stand the same distance from the axis of the instrument. When a test-piece is inserted, these platens, having been properly adjusted, will be forced outward symmetrically, as the springs are of equal strength, and will therefore carry the frames with them. As the edges of these platens are parallel and bear directly against the surfaces of the test-piece, they will cause the frames to stand parallel to it, and therefore, as the micrometers are placed parallel in the frames, they will stand parallel to the axis of the test-piece. To insure proper adjustment in a plane normal to that of micrometers, the centering screws are brought to bear against the surface of the test-piece after the side bars have been thrown over the shoulders on the frame, and the points of the micrometer have been placed under the centers of the contact plugs. Now the centering screws are forced into the test-piece slightly until they have taken a secure hold to prevent slip; after this the side bars are removed gently, and the electric wires having been attached, the apparatus is ready to measure the elongation in the measured distance adopted.

It will be noticed that the plane of contact lies midway between the centering screws, and this is one of the features of this design, as thus any flexure occurring in the gauged length does not introduce errors of measurements, as both screws and contact plugs will swing about the centering screws, and the lateral motion of the one will be precisely equal to that of the other, and the point of contact will not shift.

To the objection that the apparatus is liable to disturbance from the breaking of the scale on rough rolled rods when strained, it may be said it is only used within the elastic limit, and up to that point the scale will not become detached.

To measure elongations in 6 in., the contact plugs are withdrawn from their insulating bushes and others exactly 1 in. shorter are put in their place, while the micrometers are lowered 1 in., thus leaving the plane of contact on the medial plane of the apparatus. To measure elongations in greater lengths, longer plugs are inserted and the micrometers raised a proper amount, while side bars of the required length replace those previously used.

This apparatus can be used with all shapes, from a fine wire to a piece measuring 1½ in. in all directions. It is claimed that it is symmetrical in construction; may be applied equally to all shapes; its symmetrical adjustment about any piece is certain; it can be exactly adjusted to any length; and the large size of the micrometer heads gives large subdivisions and avoids the errors due to the momentum of the hand, and as the least force is required to turn them, ready and accurate manipulation is secured.

The second apparatus to which reference has been made is called commonly a modulus apparatus, because the modulus of elasticity is determined by observations made with it. Fig. 3 shows the details of its construction. It consists chiefly of a graduated circle, C, with a concentric boss, free to revolve over a vernier in a horizontal plane, when strained by a tape attached to the hub and an attaching post.

The frame, A, so constructed as to be easily attached to any rod, carries the vernier bracket by a steel stud-pin normal to the plane of rotation and concentric with vernier, V. This bracket has a lug through which a light rod passes, carrying a lens, L (Fig. 5), opposite the vernier, and which can be readily adjusted for use. The upper part of the stud-pin is also the axis of graduated circle, C, which latter is provided with a spring case containing a clock spring, one stud of which is attached to spring case, while the other is attached to the stud-pin. By means of this spring the apparatus returns to the original reading upon removal of the load on the bar to be tested.

The gauge rod which carries the frame is secured to definite points on the bar by means of center punches pressed into the punch marks on the bar, and held firmly by means of springs straddling the bar. As one end of the gauge rod must be free to move with the elongation of the bar under varying loads, the free end slides in a slot in the post, D, held in place by a spring and center punch, G. The upper end of this post is split, and is provided with a thumbscrew to fix the free end of the pulling tape, which is secured to the hub below the circle.

Thus having made two center punch marks, spaced a certain distance apart, the center punches in the end of the gauge rod and post are dropped into these points, and the springs placed so as to press on the heads of the center punches and on opposite sides of the bar. The tape having been previously fastened, the apparatus is ready to work, and upon a load being applied to the bar and stretching it, the free end of the gauge rod will slide in the post, thus causing the circle to revolve over the vernier. Upon release of stress, the spring will cause the circle to return to its original position.

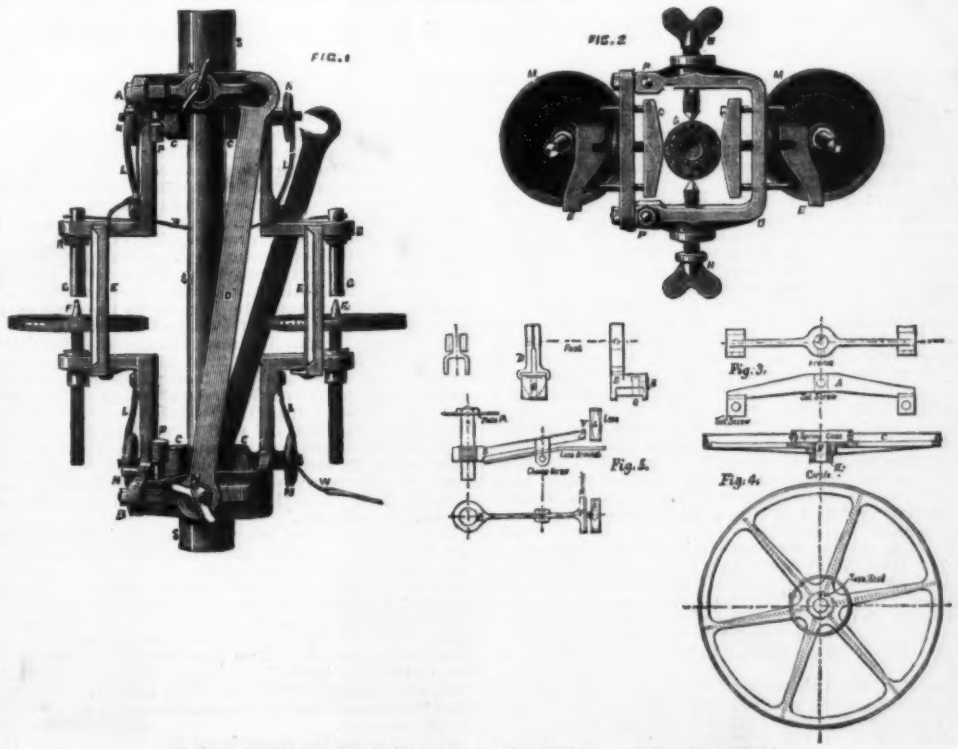
It will be noticed that the apparatus is balanced, and as the motion is in a horizontal plane, the disturbing effect of tremor and jars is entirely avoided; also, the center of gravity is always in the same position.

CHIMNEY AT MECHERNICH, GERMANY.*

THIS remarkable chimney shaft has been erected with a view to get rid of the fumes from the smelting furnaces at the works of the Mechernich Lead Mining Company near Cologne, Rhenish Prussia.

The works of the company are situated in the mountains, at an elevation of about 2,000 ft. above sea-level,

* A paper entitled "Description of a Circular Chimney Shaft at Mechernich, near Cologne," read at the Institution of Civil Engineers, London, by John Mackworth Wood, Assoc. M. Inst. C. E.



HENNING'S TEST RECORDING APPARATUS.

and, consequently, this shaft is exposed to high wind pressures.

It has been previously stated that it is the tallest shaft in the world, but such is not the case, as there are two taller shafts in Great Britain, namely, the Townsend shaft, Port Dundas, Glasgow, and the St. Rollox shaft, Glasgow; the next in magnitude being the Mechernich shaft. For the sake of comparison, the leading dimensions of the three shafts are given:

TOWNSEND SHAFT.

	Ft.	In.
Total height from the bottom of the foundation to the top of the coping..	468	0
Height from the ground line to the top of the coping.....	454	0
Outside diameter at the ground line...	32	0
" " " top.....	13	4

Total weight of the shaft, about 8,000 tons.

ST. ROLLOX SHAFT.

	Ft.	In.
Total height from the bottom of the foundation to the top of the coping..	455	6
Height from the ground line to the top of the coping.....	435	6
Outside diameter at the foundation ...	50	0
" " " ground line...	40	0
" " " top.....	13	6

MECHERNICH SHAFT.

	Meters.	Ft.
Total height from the bottom of the foundation to the top of the coping.....	134·6	=441·48
Height from the ground line to the top of the coping	131·1	=430·0
Foundation 12 meters square ..	12·0	= 39·36
Base at ground line 10 meters square	10·0	= 32·8
Diameter at plinth, which is the point where the circular shaft commences, 10 meters (32·8 ft.) from the ground line is, ...	7·5	= 24·6
Diameter at the top outside.... .	3·5	= 11·48

Total weight of the shaft, 5,459 tons.

	Meters in Height.	Feet in Height.	Thickness of Wall in Meters.	Thickness of Wall in Feet.
1st section base..	10·00	32·80	3·75	12·30
2d " " ..	3·00	9·84	2·00	6·56
3d " " ..	3·85	12·62	1·93	6·33
4th " " ..	4·15	13·61	1·86	6·10
5th " " ..	4·00	13·12	1·79	5·87
6th " " ..	4·00	13·12	1·75	5·74
7th " " ..	4·50	14·76	1·68	5·49
8th " " ..	4·25	13·94	1·61	5·28
9th " " ..	4·05	13·28	1·54	5·05
10th " " ..	4·50	14·76	1·47	4·82
11th " " ..	4·15	13·61	1·40	4·59
12th " " ..	4·05	13·28	1·33	4·26
13th " " ..	4·35	14·26	1·26	4·13
14th " " ..	4·30	14·10	1·19	3·90
15th " " ..	4·10	13·44	1·12	3·67
16th " " ..	4·32	14·16	1·05	3·44
17th " " ..	4·05	13·28	0·98	3·21
18th " " ..	5·30	17·38	0·89	2·91
19th " " ..	4·00	13·12	0·82	2·68
20th " " ..	4·54	14·89	0·75	2·46
21st " " ..	5·50	18·04	0·68	2·23
22d " " ..	5·10	16·72	0 61	2·00
23d " " ..	5·65	21·81	0·53	1·73
24th " " ..	6·01	19·71	0·46	1·50
25th " " ..	6·40	20·99	0·39	1·27
26th " " ..	5·28	17·31	0·32	1·04
27th " " ..	6·70	21·9 cap	0·25	0·82

The foundation, base, and a height of 13 meters (42·64 ft.) of the circular shaft were built in the autumn of 1884, with scaffolding on the outside. The works were then stopped on account of the autumn storms. The other portion of the shaft was commenced on the 14th of April, 1885, and finished on the 19th of September in the same year. During this time the weather was very unfavorable, there being only one hundred and seven working days, in which time a height of 108·1 meters (354·56 ft.) of the shaft was erected by an internal scaffold. The daily rise of the shaft was 0·6 meter to 2·0 meters (1·96 ft. to 6·56 ft.), according to the thickness of the wall and the state of the weather; no working day was lost to allow for the hardening of the mortar. The average number of men employed daily on the scaffold in the construction of the shaft was eight. The materials for the erection of the shaft were raised through the internal scaffold in a bucket having a capacity of ¼ cubic meter (17·65 cubic ft.), by a small locomotive engine, which ran on a line of rails starting from the bottom of the shaft. The whole of the masonry and brickwork throughout the shaft is built in lime-mortar mixed-with good, sharp sand, with an addition (decreasing from the bottom to the top) of 12 per cent. to 10 per cent. of Portland cement.

The internal scaffolding was of the nature of a shaft, and was carried up some 30 ft. in advance of the brickwork, for the convenience of hauling up the materials and moving up the bricklayers' scaffolding as the brickwork progressed. Inside this scaffold-shaft, or framing, was the bricklayers' scaffolding, which was fixed to the scaffold-shaft, and occupied about eight men in its erection for one hour per day. Up to the present the shaft is perfectly sound, and no iron hooping has been required. The shaft is provided with an efficient lightning conductor.

The weight of the whole structure, including the foundation, is 5,512,650 kilos. (12,127,830 lb. = 5,459·3 tons), and taking the area of the outside of the foundations as 146 square meters (1,570·96 square ft., 12×12 meters + 2 square meters for the projecting buttresses), the load per square meter on the rock foundation is equal to 37,757 kilos. (8,306·5 lb. per square ft. = 3·7 tons per square ft.). The pressure per square ft. at the top of the base of the stalk, where the circular work commences, is 9·61 tons. The height of the shaft from the ground line is thirteen times the diameter at the ground line.

In calculating the stability of the shaft to resist the pressure of wind, a pressure of 783 kilos. per square meter, or 160·38 lb. per square ft., has been assumed. In working out this calculation for the bed-joint at the base of the stalk, the relation of the moment of stability to the moment of pressure of wind is such that they balance about the extreme outer edge of the shaft. This leaves no factor of safety with a wind pressure of 160·38 lb. per square ft. Notwithstanding this result, it will be seen that the shaft has ample stability when it is considered how great the wind pressure has been assumed to be—a quantity nearly three times greater than that assumed by Professor Rankine and the English Board of Trade. The author is of opinion that had this shaft been built in England, the conditions of construction would have been somewhat different. In the first place, the mortar would have been made entirely of Portland cement or blue lias lime, not mixed together, as described. Secondly, the shaft would have been so designed that the pressure per square foot on the rock foundation would have been reduced; also the large pressure of 9·61 tons per square ft. at the bed-joint, where the circular work commences, could have been considerably lessened by increasing the size of the base, thereby increasing the stability. The author thinks that had this shaft been built with a "hollow batter," or logarithmic line, its appearance would have been improved. The vibration of the shaft at the top is small.

For a great portion of this information the author is indebted to Mr. Julius Matton, of the Mechernich Lead Mining Company.

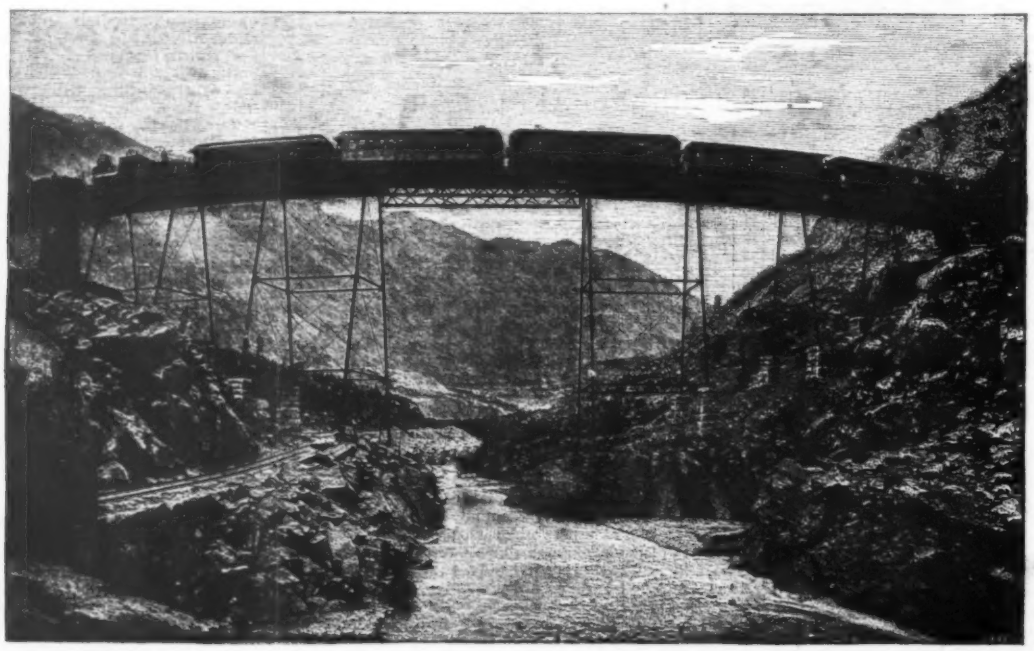
CANALS AND RAILWAYS IN COLORADO.

FROM an interesting letter by a correspondent of *Engineering*, who attended the recent Denver meeting of the American Society of Civil Engineers, we extract the following. Speaking of a visit to Greeley to inspect the irrigation system, he says: This is the glory of Colorado, and indeed without it the State would be almost a desert. In some parts of the State there is ample water supply, and this is fed by the snows of the Rocky Mountains, which are deep, and on many peaks remain all the year. By collecting this supply through canals and feeders, and distributing it over the portions needing it, the whole face of the country is rapidly changing. The present methods are rather crude, and are the immediate development of necessity; the gradients vary from 1 ft. in a mile to 10 ft., ranging below 3 ft. The Citizens' Canal has a fall of 1 in. in 10,000 ft. at one point, while the Del Norte Canal, running through a rock cut, falls 30 ft. in a mile. The standard of measurement is a cubic foot per second, and this, it is stated, will irrigate 50 to 55 acres. One of our views shows that portion of the canal running through Platte Canon, while another illustration is given of one of the aqueducts.

The entire canal system of Colorado embraces over 800 miles of large size canals completed and about 150 miles projected, and about 3,500 miles of canals of secondary size. The extent of the distributing territory is about 40,000 square miles, and the entire system has cost from 10,000,000 dols. to 12,000,000 dols. The total area supplied is 2,200,000 acres, and the arable land is 26,000,000 acres. In one case a flume crosses Bijou Creek at a height of 30 ft. and is 2,700 ft. long. These considerations show what the enterprise of Colorado is, and how alive the people are to the needs of their land. The next day's trip, which was of a grand and imposing character, was a ride to Georgetown through the beautiful Clear Creek Canon.

Descriptions fail to present this ride adequately, and reliance must be principally placed on the engraving accompanying this notice to convey to your readers what we saw. The maximum grade is 211 ft. to the mile, and the shortest radius is 478 ft. The first view is of Inspiration Point, and is sufficiently inspiring to tempt any one to take the ride. It may be remarked here that the progress of civilization has changed the waters of Clear Creek from their original color. This creek is of a muddy yellow, due to the dirt washed in from the tailings at the upper end, but it rushes alongside the track with great force, and frequently leaps over a rock with a roaring sound at once melodious and startling.

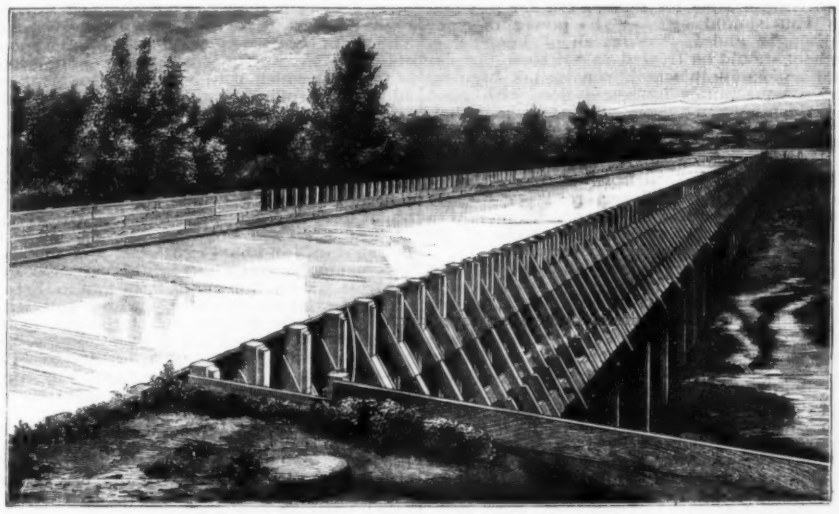
The engraving shows another sinuosity of a narrow gauge railway, and the engine plunged around this curve as though it was thoroughly used to it, and liked the fun.



VIADUCT AT LOWER END OF LOOP, NEAR GEORGETOWN—UNION PACIFIC RAILWAY.

At Idaho Springs we found hot wells, swimming baths, and natives anxious to sell us "specimens." These consisted mostly of bits of pyrites and galena ore, whose luster renders them very salable to strangers.

At Golden there is a university and a mining school, and indeed there are the greatest facilities for a practical education in this branch. That it is sorely needed in Colorado is evidenced by the many unsuccessful prospectors whose abandoned claims point sadly to the passers-by the futility of human hopes, and seem to be



AQUEDUCT ON THE PLATTE CANAL.

warning ghosts of the past against rashness and too great trustfulness.

The view from Black Hawk from the passing train showed the smelting works and other industries, and suggested to the writer that there was more money in smelting than in mining, just as the broker who does a commission business in stocks grows rich while his patrons lose millions.

At last Georgetown came in sight, and we rapidly ran round the town and proceeded to the celebrated Loop. The view shows the viaduct at the lower end. It may be remarked that to make two miles 3·9 miles are traveled, and an elevation of 623 ft. attained; the average grade is 160 ft. to the mile, and the maximum grade is 190 ft. At the point where the road runs under itself, the viaduct spans the valley; the distance between the upper and lower tracks is 75 ft.

THE BROTHERHOOD OF RAILROAD BRAKEMEN.

THE Brotherhood of Railroad Brakemen held a very interesting and well attended meeting at Des Moines, Ia., on the 25th of July last. After the close of their secret lodge work, the members were most agreeably entertained by a number of brief, but eloquent, addresses. Grand Master Wilkinson briefly reviewed the history of the order, in a speech which was remarkable for its sound common sense. Mr. Wilkinson was followed by Mr. C. F. Meek, superintendent Wabash, St. Louis & Pacific Railway, who delivered an address that will bear careful reading by employes of every grade. We give Mr. Meek's speech in full:

GENTLEMEN: I notice by the preamble of your constitution that the object of your organization is to protect the families of its members "by the exercise of a systematic benevolence," and, further, to advance their interests, social, moral, and intellectual. You seek to perform two great duties—one to your families, one to civilization. You bring to the discharge of these duties that which is noblest and best in human nature, and you cannot fail of achieving good.

Your duty to civilization, however, leads you beyond the council chamber, beyond the circle of your order, and brings you as brothers beside your fellow man in whatever condition you may find him; to help him onward, if he needs help, or, if he needs light, to give him that.

If the result of your fraternity is to broaden each other in the view of life, to strengthen each other morally, to help bring that which is attractive and bright and refining into the lives of each other, so much the better for you, so much the better for the world. We need the help of every fraternal feeling, of all our brothers, to reach the happy result in life.

I believe I am right when I say that you seek through your organization to enlarge, expand, and improve the relations of individual members with the rest of the world, and not to make your council chambers nor the circle of your profession which brings you together the boundary line of your fellowship; that through this union you seek that illimitable fellowship which stands for so much in our country of liberty and progress.

It is wise, however, to consider the extent to which a man may be aided by fraternity. It may improve his condition socially and intellectually, and give him some advantage he might not otherwise have. But there is a point where a balance is struck with his individual merits. Neither society nor fraternity can make a successful man. Do not get the false idea that organization, becoming mighty, can force the success of individuals. That is the wildest fancy. There is a class of individuals who shun the workshop themselves, to whom labor of any sort is a nightmare, who will tell you that you can organize to capture the world and divide it among you. They see men engaged in the same field of labor organizing for mutual benefits to each other, and at once become "disinterested" champions of their cause, and, with the cry of oppression and hardship and hunger, picture the thrift of employers as a crime, and capital a breathing monster. In this way they strive to organize these unions against the world, and, in fact, against the men composing them.

We have seen the fruits of the labors of this sort of men. We have seen it in Illinois, in Missouri, in Texas, where it cost the hard working and honest men who thought they were organizing for mutual benefit and individual advancement, upward of $2,000,000 in less than two months, and this is a single class of workmen—I am speaking now of the recent railroad strike. Now, were the interests of these good men in any way promoted by that united action? Was a single home made happier? Will any of them advance in the line of legitimate promotion because of that strike? Your wisdom answers, no! Over in Chicago to-day another organization has yielded to this influence of demagogues, and is passing through the same dark valley. They wish to build a stone wall around their professions, and say to the men that did not wish to enter when the gate was open, or who do not wish to knock for admission, that there is no room in this broad land for them to ply their vocation. This is a morbid condition of affairs, which could only be brought about by the most vile and dangerous influences.

The men in those organizations must learn that this country is as free as it is broad; that to live in it is to enjoy its freedom. They must learn that while they are enslaved to one, there is and can be no slavery to them. These cowardly influences are exercised with

HIGH LINE CANAL, PLATTE CANON.

PLATTE CANON.

great strategy, the chief object being to trump up what is called a grievance between the workman and his friend—for his employer is his friend—and out of that to bring a disruption and a hell of suffering and of hunger. What a fiend he must be who, having planned a strike, stands by to see the desolation of homes—the mother pleading against a miserable fate, teaching her babes with her to hope, while hunger tortures; himself the while casting about to profit by the downfall of the institution which made these same homes places of comfortable and happy abode. Then good men cry arbitrate, and arbitration comes to find that all was going well before—that the grievance was a myth.

Were it not better that these men for whom arbitration is made necessary should be each his own arbitrator, and that the arbitration should be had when the contract for employment is made? That is the privilege of every man.

If there are classes of men who have not reached that plane of intelligence, then it becomes the duty of mankind to go into the valley and lead them up where the sun is shining. That should be one of the purposes of organization.

Another purpose of organization should be to teach individuals how to discriminate between honest men and that class of hypocrites called demagogues. If this nation is in any danger, it is that danger which results from the perfection in the science of demagogery to which an army of lazy and conscienceless men, bent upon tearing down everything which seems to have a substantial foundation, have obtained. They have reached a point where they frequently succeed in making good people believe that the progress of civilization is the result of corruption. There is but a hair's breadth between the demagogue of to-day and the anarchist. The business of one is to disrupt, the other to destroy.

It is well to guard against them both. They see it is easier to use organized bodies of men than it is the entire people; and, as I have already said, we have seen the results.

I mention these things merely to call the attention to the evils which have been practiced through organizations that were made for worthy purposes. Your own union has up to this time been one of exceptional conduct and great benefit. Your brotherhood has been worthy the name of brotherhood.

Keeping in the bounds of the objects set out in your constitution, you have—and it is known to the world—stood hard against the strike and its evils. When the commerce of the country was being interrupted and a partial state of anarchy was threatened, your organization, together with that of the conductors and engineers, did as much as, if not more than, any other influence toward restoring affairs to their proper condition. You have always been found at your post on the side of good sense and good citizenship. I believe you will continue in this way. I believe that you realize that these great thoroughfares of commerce, in whose operation you take so important a part, are the results of thrift and industry; that they were conceived and put forward by men no more than your equals, who have been successful after long years of ceaseless toil; and that they have put the fruits of their labor out on these great fertile prairies, giving value to land that before lay waste; making the farmer rich in the value of his land, bringing to his door all the comforts known to life in any quarter; bringing into action in a thousand different channels the energies of millions of men, and giving employment to thousands of men, in the confidence that their property would be protected by those who have reaped so many and so rich benefits, and who will continue to do so, from the existence of that property, and in the hope that out of their investment might come a fair return. I believe you concede that the success of individuals in these grand undertakings is legitimate. They form what is called a corporation, about which we hear so much. That is the scorpion that gives so much trouble to those fellows with small but active brains, poor digestion, and lazy hands, who want to get in without paying. There are evils practiced in corporations; there are faults in the management of their affairs; it may be that justice is not always done to employes. But what is the business free from evils and from faults? Put yourself in the place of the men who operate these great properties (some of you will be there, in fact, some day), consider carefully their many cares and great responsibilities, and you will realize what incessant work and careful watching it takes to do simple justice to the public, the employes, and to the owners of the property. We should not be unreasonable in expecting too much for ourselves.

Every soldier cannot be a Napoleon, nor can every railroad man become a manager. The legitimate road to success is open to every one.

The man who goes at his work determined to win; who in the employ of others enlists for them his head and heart as well as his hands; who is as diligent and careful of his employer's interest as he is anxious to succeed; who, under supervision or alone, is true to his trust, and who knows the value of time and the value of a dollar, will surely succeed. Mark you, employers of all kinds are constantly watching for that sort of men, and when they find them, not only give them their confidence, but put them forward. Besides, that kind of men are certain, in a reasonable time, to be able to put themselves forward I believe every man possesses the ability to work out the destiny for which he is intended. But it cannot be done loitering by the wayside.

Now, I want to say a few words to you confidentially. I believe that you feel that my heart is with you, and that you will take it in good part. A majority of your union is composed of young men, and the most of life is before them. I want to ask you to read the great open book of life that is before you, to profit by the thousands of examples of men who began from a dead level and have risen to the highest positions of responsibility and honor. Think of these things, and take them to yourselves to build upon. You will see in these examples every kind of hardship and self-denial. But you must have the courage of self-denial and the courage to take hardship as a most gracious master. Do not think with the advancement comes comfort and ease. Every step you take higher brings greater responsibility and greater hardship, until the top is reached, when you come in that great sea of high breakers where the storm never ceases, where there is no rest.

Did you ever stop to think, when seeing your general manager pass over the road, that he is the most constant and hardest worker of all; that if there is any slavery in railway life, he is the slave?

Yet it is natural for all to aspire to reach some position of trust, and what I wanted to tell you confidentially was this: That you cannot do it, if there is envy for your fellow man in your heart; that you cannot do it, if you abandon yourselves when off duty to idleness and bad society, to drinking and enjoying the luxuries that blight while they intoxicate.

You need certain time for repose, but for rest and recreation you should exercise the power of your mind in thought and in the search of knowledge. Every moment should be treated as priceless, because there is not a moment in which you cannot improve and broaden your minds by association with good books, and the more you associate with them, the better you will like them, the better you will think of yourselves and the world.

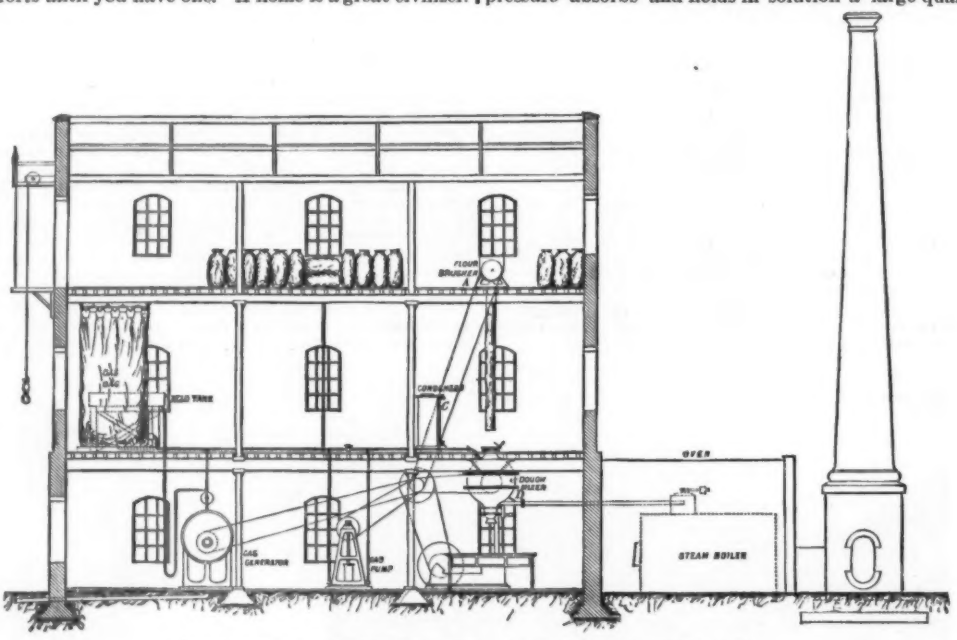
Do not waste any time on bad literature, when you can find so much with a little effort that will be of solid benefit to you. Read history, read the lives of great men, read the works of the philosophers who have spent their lives in measuring the depths of life for your benefit.

Remember that your work is honorable, and that it is so regarded by all good people. It is only snobs that sneer at labor; every hope of civilization depends upon it. Take from man his tools and his strength, and he is the most helpless of creatures, but with tools and strength and mind combined he is the most powerful. So I say that none but snobs sneer at toil, but for which, by others, they could not exist.

Remember that in this great, free land you are sovereign citizens, and that there is no limit placed upon your achievements. There is but one class in this country, and that is the great sovereign mass in which all are equal. Be contented; not to the extent of being slothful, but to reap the reward that patience and hard work always bring.

If you do not own a home, never relax in your efforts until you have one. A home is a great civilizer. Every home makes a good citizen. Besides, it realizes to man the best treasures of earth. Happy is the man who, contented with his lot, fills with his coming to a pleasant home, wife and children with transport of joy, and who adds to the comfort and peace and progress of the world.

I wish for your union success in the attainment of its objects, and to individuals composing it I wish that success which I am sure they will deserve, and which attends, with rare exception, those who really do deserve it.



MANUFACTURE OF AERATED BREAD.

AERATED BREAD MAKING.

By KILLINGWORTH HEDGES, M. Inst. C. E.

I.

FOR a long time, medical men, and hygienists generally, have recognized the importance of preparing bread which has not undergone the ordinary process of hand kneading and fermentation, and as far back as 1832 letters patent were granted to Luke Herbert for an invention with this object in view; but no practical working of the system took place or was possible at that date, and nothing further was done for more than twenty years toward removing the objections to hand-made bread, although numerous patents from time to time have been granted for improving the quality of bread. To Dr. John Dauglish the public owe the simple process by which aerated bread is made, and it is proposed in this article to give a general description of the arrangements to be found in a modern aerated bread bakery. An admirable instance might be named in the central establishment of the London Aerated Bread Company, which is the largest bakery where the aerated process is exclusively adopted. Its capacity is equal to 1,000 sacks of flour converted into bread per week. The illustration above shows a vertical section through an aerated bread factory recently designed by the author. The flour, on arriving, is carried up in the hoist to the top floor, where every consignment is tested, and if not of requisite strength, the first operation is to blend it with a stronger flour, this being effected in a mixer, not shown in the engraving, but consisting of a circular vat in which revolves a three-bladed vertical screw. From the mixer the flour is discharged into the cleaner, or brusher, which removes from it the dirt so especially prevalent in foreign flour. The value of this machine may be seen at once by examining the dirt box, the mass of fluff and dust therein showing what ingredients help to make the ordinary bread as supplied by the baker.

To understand the next stage in the manufacture—the aerating process, by which the flour is made into dough highly charged with carbonic acid gas, and only requiring the heat of the oven to complete its expansion into loaves—it will be well to consider how ordinary bread is made. The first step is to make the "ferment," which is a mash of potatoes and flour, to which brewer's yeast, or what is called patent yeast, is added. The next operation is called "setting the sponge," and consists in mixing the ferment with about a fourth part of the flour which is to be made into bread, with the addition of sufficient water. This is extremely laborious work, and takes a good man fully twenty minutes per sack of flour. The sponge remains about six hours to undergo fermentation, and during this time it rises twice, the working baker taking his sleep in the interval. The remaining three-fourths of the flour are now added, and the whole mass is kneaded by hand, about forty-five minutes being required to make a sack of five bushels of flour into dough. After this, the dough stands an hour or so, when it is weighed off into loaves, moulded, and put into the oven as quickly as possible. Here it remains from two to three hours at a temperature of about 400°, passing through the process of complete cooking and formation of the crust. When cooled down, it is ready for delivery. The whole process of hand baking occupies nearly twelve hours from the setting of the sponge to the withdrawal from the oven, and during the whole of this time it requires attention.

By using the aerated system, on the contrary, the same quantity of bread may be made, untouched by the hand, in one-ninth of the time. The aerating process is a repetition of what has just been described, excepting that the result is achieved by the use of water highly charged with carbonic acid gas. The invention of Dr. Dauglish is based on the fact that water under pressure absorbs and holds in solution a large quantity of this gas, which escapes when the pressure is diminished. The apparatus now employed permits of a large quantity of dough being quickly aerated and made into loaves. To continue a description of the process, by aid of the illustration, the flour, after passing through the cleaner, is discharged into the dough mixer, which is a cast iron vessel carefully enameled inside, and is strong enough to resist the gas pressure of about 40 lb. per square inch.

There are several of these mixers arranged in line facing the ovens, and above each one is placed a tall cylindrical vessel termed the condenser, C, containing water to a height which can be ascertained by means of a gauge glass outside. The carbonic acid gas, which has been prepared in the gas generator, is first purified by being passed over lime, to remove any free acid, and is then forced by means of pumps into the condensers, where the water immediately absorbs it. What is usually termed "soda water" is now ready for turning into the flour in the mixer. In the original Dauglish process, a very high gas pressure was required. This heated the pumps so much that they had to be surrounded with a water coil. Only 40 lb. pressure is now used, and this is easily obtained by a small gas pump, similar to those employed in mineral water factories. The gas is made in the usual manner, but it has been found preferable to store it in large India-rubber bags, from which the pump draws its supply and to which a certain amount of gas is returned after the aeration of the dough is completed. Very little kneading is required in the aerating process, since, as soon as the communication with the condenser is opened, the gas-impregnated water rushes into the mixer, and the development of gas agitates the mass of flour. A set of arms are caused to revolve within the mixer, and a few turns are quite sufficient to produce a stiff dough, which is thoroughly charged with gas. The bottom of each mixer is provided with several holes, closed by special valves termed "dough cocks." These are so arranged that when the handle is turned round, the hollow plug of the cock takes out sufficient dough to speedily expand into a loaf of the shape of the tin or receptacle into which it is dropped. No special skill is required; a laborer works the handle, the dough drops out upon a scale, and, if correct weight, is at once

passed down a board into the oven, where it is placed in position in the ordinary way. When the writer first became acquainted with the process, great difficulty was experienced in preventing a dark colored stain from appearing in the bread. On investigation, this was found to be due to acetous fermentation, set up by reason of small portions of dough being left in the mixer. These dissolved minute particles of iron, and thus contaminated the ensuing batch of bread. To remove this objection, the whole of the interior of the mixers are now enameled with a special vitreous preparation, free from arsenic, and which will not chip off. Similar enamel is used for the interior of the condensers and all the iron pipes. The revolving arms in the mixers should also be enameled, and constructed of a shape which experience has shown to give the best imitation of the hand mixing and kneading process. To prevent leakage through the stuffing boxes of the dough cocks, the glands are packed with asbestos, and no oil is used. The aerating process is only partly completed when the bread leaves the mixers; the heat of the oven is required to remove the carbonic acid, which on expansion forces out the loaf, and causes it to assume the moulded shape. Bread made in the manner described is unfermented, and objections have been raised as to its want of porosity and its heaviness, in consequence of the flour starch remaining unconverted. In the improved manufacture of aerated bread, such as is carried on by the London company, what is known as Child's system is adopted, and the great popularity of the bread sold in the London shops is due to this simple addition to the Dauglish process. Instead of making an unfermented dough with water charged with carbonic acid gas, a fermented liquor, technically known as "wine," is added to the aerated water in the condenser, with the result that when the mixture is discharged into the flour the whole mass is permeated with the ferment, and the vesicles of the bread expand equally throughout. This accelerates the process, and imparts a flavor to the bread which greatly improves its quality. The appearance of the bread is also changed by the use of Child's process, and were it not for the special shapes in which aerated bread is sold, it would be impossible to distinguish what is termed the Paris loaf from the best quality of baker's bread made from the finest Hungarian flour. On breaking the Paris loaf, we find the same silky appearance and pure white color.—*Industries.*

LOZE & HELAER'S FILTERING APPARATUS.

IT is for the government to be solicitous about the elevation of our sugar industry, but it belongs to the manufacturer to so improve his apparatus and processes as to obtain from prime beets such a yield that there shall be an excess free from tax.

One of the questions that is being more and more brought to the attention of interested parties every day is that of the suppression of bone-black. There are already a number of works that no longer employ this purifying material, and that have substituted mechanical filtration for it.

The results obtained from this method of working soon showed the advantages that resulted from the disuse of bone-black. Among the apparatus devised for this purpose, Messrs. Loze & Helaer's multiple-acting filter appears to us to be called upon to render genuine services.

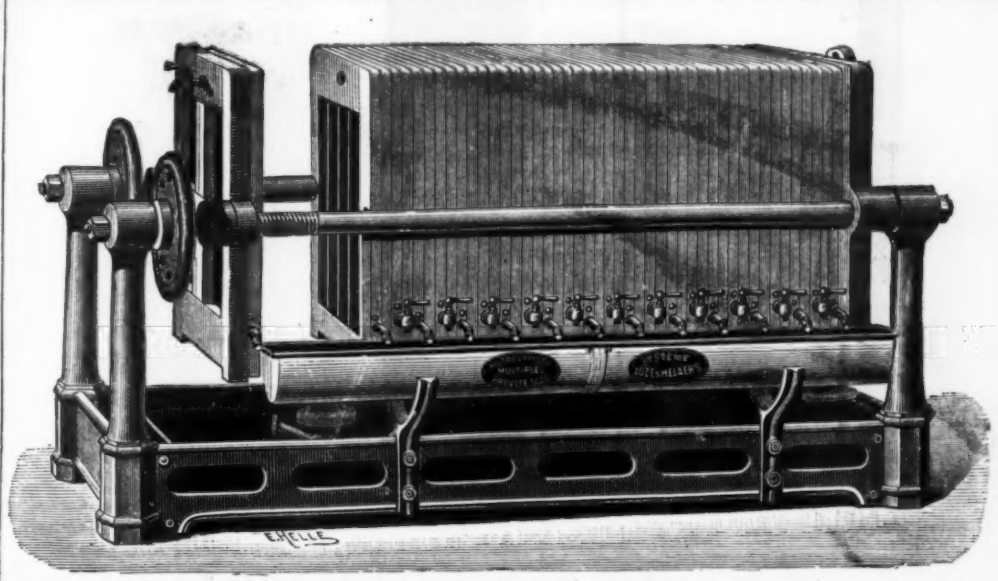
Perhaps it is not superfluous to recall the fact, that at the epoch at which bone-black was proposed for the purification and clarification of beet juice, the processes of purification left much to be desired. As simple defecation left a large quantity of lime in the juice, its useful effect was doubled by the adjunction of animal charcoal filters, which removed the excess of the alkaline earth. After this came carbonating; but, as this ended in a high degree of alkalinity, through an exaggerated fear of alterations, the absorbing power of bone-black was still found efficacious. At this time it was not suspected that carbonic acid was capable of performing the role of charcoal, that is to say, of perfectly and completely eliminating the lime and its organic salts. It was by furnishing juice of a high degree of potassic and sodic alkalinity that diffusion clearly showed that it was possible to abandon the use of bone-black in sugar works.

Subsequently, numerous researches have been followed by an improvement of the method of purifying by lime and carbonic acid. In fact, carbonating alone now constitutes the most efficient mode of purification, and it is not necessary to call upon bone-black to lessen the defects of this operation, which is one that must be conducted and watched with great care. The results obtained by several works that practice mechanical filtration show that it is easy to produce in this way sugar of the highest standard, and to obtain the largest amount of yield.

Considered from the standpoint of mechanical filtration, bone-black is far from furnishing good results. A proof of this is seen in the attempts made to use cotton sacks, designed to remove the greater part of the impurities in suspension in the juice before being sent to the charcoal filters. But these sacks did not permit of dispensing with the charcoal, and were therefore abandoned. After this various inventors talked up the sponge filter, the closed chamber filter, the superposed cone filter, artificial filtering materials, and asbestos and charcoal beds, none of which satisfied the behests of practice.

The Loze & Helaer apparatus is in shape like an ordinary filter press, that is to say, it consists essentially of a cast iron support, of frames sliding upon two bars, of two screws with hand-wheels, of a dripping-pan at the lower part, and of a gutter to catch the filtered liquid.

The filter is provided with fifty-three wooden frames, which are entirely free within. In the upper cross-piece of each of these there is an oval aperture that forms the channel through which the liquid enters when the apparatus is mounted. The frames are divided into three distinct categories, that have peculiar arrangements, viz., entrance frames, intermediate frames, and exit frames. The juice enters the first of



LOZE & HELAER'S FILTERING APPARATUS.

these through a small vertical conduit which is bored through the upper cross-piece and communicates with the large distributing canal. The second ones have no aperture. As for the third, they may be arranged in various ways. The juice may be let out either through an external cock at the lower part of the frame, or else through a small vertical conduit, communicating with a large collecting channel. This collector may be hollowed out either in the upper or lower cross-piece. The cocks and gutter are thus done away with. The arrangement to be adopted varies naturally according to the mode of application of the filter.

In the simple-acting filter, when the exit of the liquid must occur through a collecting channel, the latter is located at the upper part of the frame.

In the double-acting filter, there is no exit collector, a cock fitted to each frame being indispensable in order to permit of watching the state of the juice at its exit from all along the apparatus.

The frames are mounted in the following order: (1) entrance, (2) intermediate. (3) exit; (5) entrance, (6) intermediate, (7) exit, and so on. Each one is provided with filtering cloth of exceedingly fine texture. The juice on entering from No. 1 passes through the cloth that separates the latter from No. 2, and then through the one that separates No. 2 from No. 3, and then makes its exit. There is the same passage from No. 5 to No. 4, then to No. 3, and from No. 5 to No. 6, then to No. 7, etc. When, instead of the entrance and exit frames being separated by a single intermediate compartment, there are two, three, or four of the latter, the juice successively traverses three, four, or five filtering cloths. The filtration is then multiple, and hence the name given to the apparatus. On the contrary, if the intermediate frame is suppressed, the apparatus will be a simple-acting one.

The apparatus is very easily put in running order. It suffices to set it anywhere that is convenient, and to connect it with the pipe that supplies the juice as well as with the reservoir that receives the filtered product. Once set running, the apparatus requires no looking after. In working with ordinary beets, it operates uninterruptedly during the following periods: from first to second carbonating, from 12 to 24 hours; after the second carbonating, from 3 to 4 days; after concentration, from 12 to 48 hours. Applied to sirups of the second run and to the products of osmosis, the time of continuous running is not very constant, varying from 3 to 12 hours, according to the nature of the liquid.

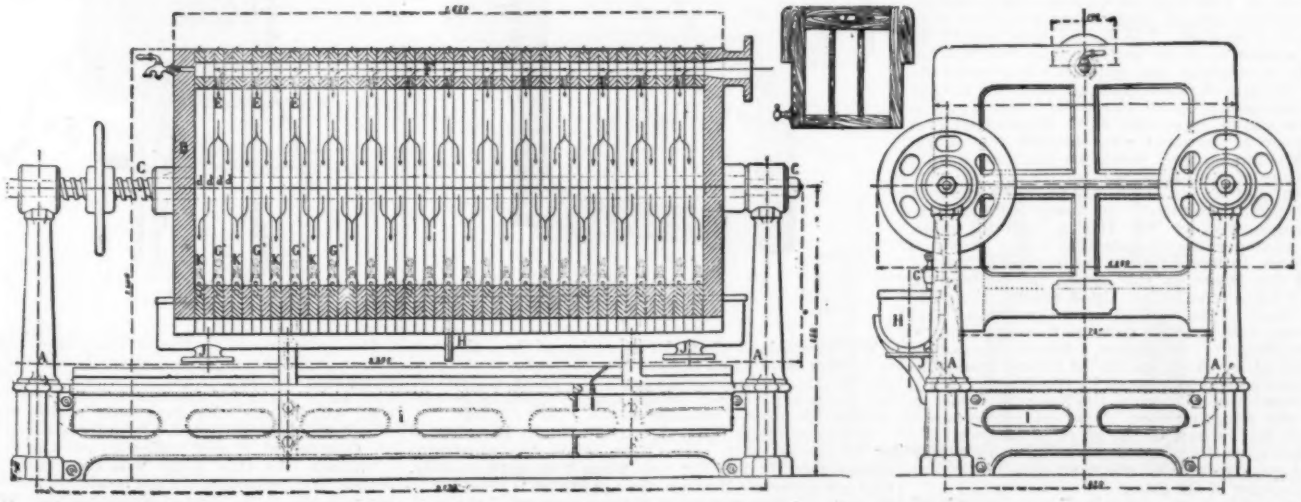
The filtering surface is easily and quickly renewed. The moment the filter is arrested, the cock that lets in the liquid is closed, and the filtration is allowed to proceed a little longer, if it is desired to empty the frames. If it be desired to effect the emptying more rapidly, the cocks provided for the purpose at the base of each of the frames in the single-acting apparatus, but only at the base of the first frames in the double-acting ones, are opened, when the residue will flow into a gutter at the side opposite the one that carries the gutter for the filtered liquid. When the series of filtering cloths of the first frames are clogged up, they are replaced by those in the frames of the second filtration, and these latter are then provided with new ones. To effect this, the screws are loosened, and the cloths are removed by pulling them out through the tops. When the new ones are inserted, they are suspended, through three eyes, from corresponding hooks in each frame.

The stoppage of the apparatus, its exhaustion, and the renewal of fifty-three cloths, consumes twenty minutes' time. The cloths are cleaned by washing and rinsing them in hot water.

A simple-acting apparatus filters 65 gallons of juice per day after the first carbonating, and a double-acting one 50 gallons, after the second carbonating, equal to 65 gallons of concentrated juice of from 20° to 30° Baume. An establishment making 65 gallons should therefore employ two apparatus for carbonated and one for concentrated juices, and, if need be, two simple-acting filters between the first and second carbonating.

In small works that produce about 40 gallons, the concentrated juice filter may be easily converted into a mixed apparatus, that filters simultaneously and separately both weak and concentrated juice, that is to say, an apparatus in which two-thirds of the filtering surface are devoted to the latter juice, while the other third receives the weak juice for the short space of time necessary for renewing the filtering cloths of the apparatus appropriated to it.

A simple-acting apparatus furnishes a very limpid liquid, but when the filtration is double the liquid is extraordinarily clear, and the sugar obtained from it contains but imperceptible traces of insoluble substances.



LOZE & HELAER'S FILTERING APPARATUS.

This remarkable property of the multiple-acting filter is due solely to a double filtration, under cover from the air, without any loss of heat, and through a fabric free from the pernicious action of outside influences.

It is well to add that, in order to arrive at a complete suppression of bone-black, the mechanical filter must be applied to the purification of well decanted and very clear juice, and to this its use must be confined. Under such circumstances, the working without bone-black is attended with all its advantages.—*Revue Industrielle.*

THE OPERATION OF THE SHUTTER IN INSTANTANEOUS PHOTOGRAPHY.

IF, knowing the theory of the formation of an image in a camera, we place a plate provided with an aperture in front of the objective and cause it to descend slowly, we shall see that it will first allow of the passage of the rays emanating from the upper part of the image, then of the intermediate ones, and finally of those which start from the lower part. Upon continuing the motion, it will be the rays that emanate from the top that will disappear first, and finally those from the bottom. Upon our ground glass, the sky will begin to appear, then the landscape, and finally the foreground. At this moment, the image will be complete; then the contrary will occur, the background remaining last visible.

If the plate has a uniform velocity, the lighting of the various parts, although not having been effected exactly at the same moment, will be equal as to duration.

If, on the contrary, the motion is accelerated, either through a free fall or the action of a spring, the image will be unequally lighted.

In the present case, it is the ground that will receive the shortest exposure. This result is contrary to photographic dicta, which require, on the contrary, a longer exposure for the foreground than for the heavens.

We believe, then, that, from a theoretical standpoint, cutting off the light in front of the objective is wrong. If we reason in the same way backward, we shall find that the results are just the reverse. The heavens will have the shortest exposure and the earth the longest. This solution, then, appears to us to be preferable in every respect.

The plate used by us in this demonstration is the one called the "guillotine" shutter.

We can admit, then, that in principle there is every advantage in placing the guillotine back of the objective, in preference to in front. Several persons have proposed to place it in the objective, at the optical center, or rather in a very approximate plane, so as not to interfere with the use of diaphragms. Such a position appears at first sight to be very advantageous. It seems, in fact, that, as soon as the guillotine operates, it should unmask equal quantities of the rays coming from A and B. The image, then, would be completely visible upon the ground glass from the beginning. In measure as the guillotine continued its movement, the sum of the rays admitted would always increase in the same proportions for the points A and B. The image would be more and more illuminated and then disappear in the same way through general extinction. The image, then, would be complete during the entire time of the exposure.

A deep study of the question has proved to us that the image is not os produced. In analyzing the formation of images, we had Mr. Darlot make an objective for us that permits of operating plates provided with apertures, in five different positions—in front of and behind the lenses, at the optical center, and in front of and behind the latter. Upon passing the plate or shutter back of the optical center, we found that the image was not complete from its first appearance, as had been thought. It appears, by degrees, near the center of the glass, like a spindle of a form analogous to that of the segment unmasked by the shutter. While the latter continues its motion, the image increases on both sides like a folding door. The obturation occurs in the same way, a part of the glass, in the form of a spindle, remaining illuminated the last, but in a position homologous to that of the first spindle with respect to the center of the glass.

Upon this subject, we consulted our learned colleague, Mr. Martin, who has been good enough to explain the optical reasons for this fact to the French Photographic Society. It results from this gentleman's labors that although a diaghragm, however small, placed in the axis of the objective, always allows of a complete image, a diaphragm out of center with respect to the said axis does not give the same result. In this case, certain rays alone can pass, while the others are arrested by the sun shade or are lost in the interior of the mounting. Upon the whole, if we desire to represent the manner in which the image will appear, according to the various positions of the shutter in the objective, we shall have the following table:

(1) In front, the sky will appear first.
(2) Behind, the ground will be the first to appear.
(3) In the optical center, or in its vicinity, it will be the almost central part of the image that appears.

It would seem, then, that the passage of a shutter, uncovering the objective laterally, ought to be thoroughly condemned (from a theoretical standpoint be it understood), since in the first cases the image is successive, and in the others it is unequal.

Struck by the inconveniences which, according to theory, must be presented by shutters that cut off the objective laterally, and, on another hand, observing that the proofs obtained with the said apparatus did not possess any of the defects that theory seemed to impute to them, we became desirous of knowing whence could come this difference between theoretical and practical results.

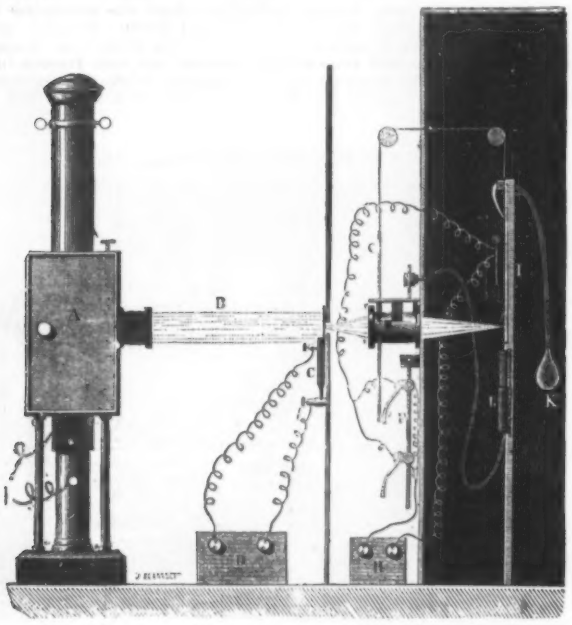


FIG. 1.

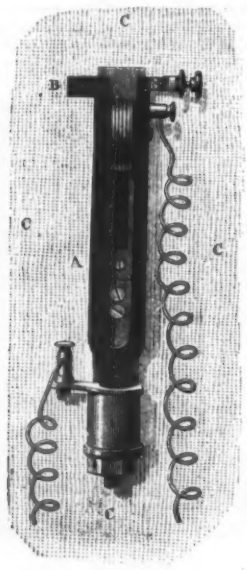


FIG. 2.

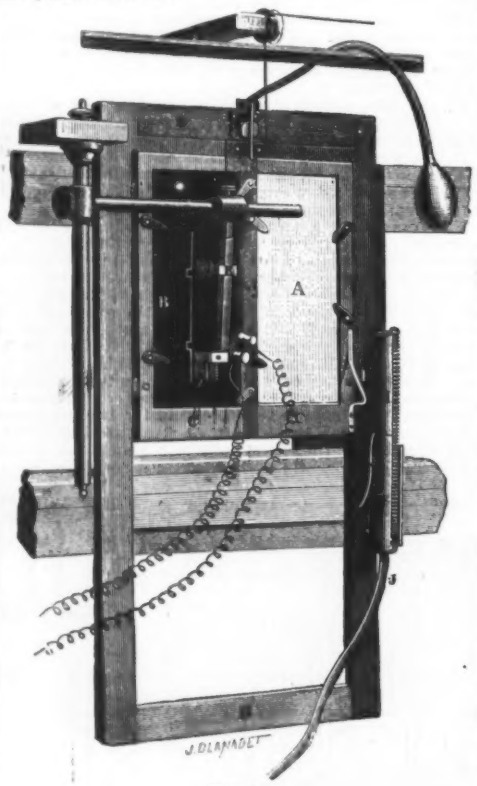


FIG. 3.

We ascertained that the operation of these shutters is not the same when the velocity thereof is moderated experimentally in order to verify the manner in which the image is produced, or when the apparatus is operating at its normal velocity.

Many an image that appears unequally illuminated or blemished with aberrations when the apparatus operates slowly does not take when it operates rapidly. Our eye perceives it when the apparatus is retarded in its motion; but, as soon as it acquires a great velocity, the intensity is not sufficient to act upon the sensitized surface. The light that enters the apparatus when the shutter is working exhibits an intensity that increases from darkness to a complete illumination, and one that depends upon the number of rays that are progressively admitted. It is, moreover, only when the intensity is sufficient that the impression begins. This is a fact that is easily ascertained in all the optical methods of photographic registering.

This granted, the following is the problem that we set before us:

To demonstrate by accurate experiment that the light, during the operation of a shutter, does not act upon the sensitized surface at the instant that it reaches it.

Besides this, it became a question for Mr. Londe (from whose work on Instantaneous Photography the preceding paragraphs are taken) to defend the cause of lateral shutters; and as the inconveniences that are ascribed to these occur only at the beginning and end of an exposure, he desired to show that precisely at these two instants the image does not form, and that by that fact is explained the anomaly that apparently exists between theory and practice.

With this intent, Mr. Londe had a very delicate experimental apparatus constructed, of which the general appearance is shown in Fig. 1. This consists essentially of the following parts: (1) of an electric lamp, A, with condenser, that gives a fascicle, B, of parallel rays: (2) of a screen containing an aperture covered with dioptric paper mounted upon an electric tuning fork, C, whose pile is D; (3) of a guillotine shutter, G, adjusted upon an objective, E, of hemispherical shape; and (4) of a registering apparatus, I. Finally, H is the pile of the chronograph; J, the double piston that frees the shutter; and K, a pneumatic bulb that operates the registering frame.

With such an apparatus, it is a question, then, of inscribing upon a moving sensitized plate the image of a brilliant point during the exact time of the shutter's operation. Mr. Londe performed the experiment, and, as will be seen further along, obtained by this method some extremely exact results.

The difficulty that he met with in the first place was to obtain a point luminous enough to give sufficient traces upon the glass during the motion of the shutter. It was necessary, in fact, to have not one luminous ray merely, but a fascicle of rays, in order that the conditions might be truly practical. He obtained such a result by covering a small aperture in the screen, B (Fig. 2), with a sheet of dioptric paper, and by employing a fascicle of electric light projected upon the screen.

As may be seen from Fig. 2, this little screen is fixed to an electric tuning fork, A, which is itself placed upon an opaque partition, C, and behind which there is another screen that forms the external portion of a camera.

Fig. 4 represents in detail the objective that Mr. Londe used, and which, owing to its numerous apertures, permits of studying the various positions of the shutter. In front of the latter, and under the objective, there is a metallic bridge that supports two parallel steel rods upon which move sliders, C, each provided with a curved spring. These springs form part of an electric circuit that actuates the chronograph placed upon the registering apparatus. The lower part of the shutter carries a rod, D, which, at the moment it passes between the two springs of the sliders, permits the current to pass, and consequently brings about a signal at the desired instant.

The registering apparatus (Fig. 3) consists, as may be seen, of a stationary frame, D, carrying two rails upon which slides an inner frame, C, through the intermedium of rollers. This latter is divided into two compartments, one of them designed to receive the sensitized glass, A, and the other a smoked plate of glass, B. It is upon the latter that the electric chronograph, E, makes a tracing.

The two apparatus are interdependent, because the registering one carries along the shutter in its fall, through the intermedium of a thread passing over pulleys.

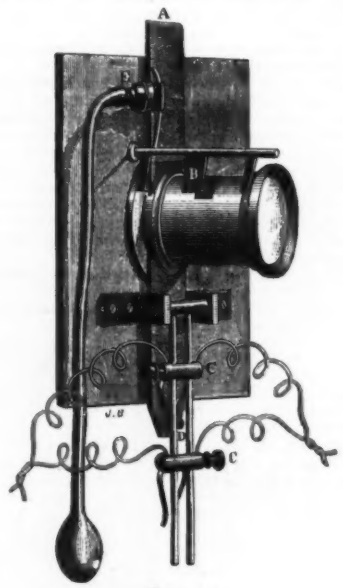


FIG. 4.

It is now easy to see that at the moment the apparatus is freed through the piston, H, and the latter carries along the shutter, the light will enter the camera and form upon the sensitized plate a rectilinear line that will be the very expression of the time during which the light has acted. In order to know the length of this period, it will suffice to set the tuning fork vibrating. As this latter will then carry along the screen, and consequently the luminous point, the tracing will affect the form of a sinuous line; then, knowing the number of vibrations of the fork and the num-

ber of those inscribed, it will be easy to deduce the length of the time during which the light has acted, Moreover, in order to completely solve the problem, it is necessary to register the appearance and extinction of the luminous point.

To this effect, Mr. Londe operates as follows: Placing himself behind the registering apparatus, he substitutes a plate of ground glass for the sensitized plate, and causes the movable frame to descend slowly until the point appears.

At this moment he fixes the frame and moves its first slider until a current is set up through the rod of the shutter to actuate the chronograph. Finally, he performs the same operation with the other slider at the moment the point disappears.

His apparatus being thus regulated, it is evident that as soon as the point appears and disappears, a signal must be made upon the plate of smoked glass. In this way, we accurately obtain the two instants between which the light enters the apparatus; and if it acts during the same period, the luminous line ought to begin at the moment the first signal occurs and cease at the second.

The results indicated in Fig. 5 show that such is not

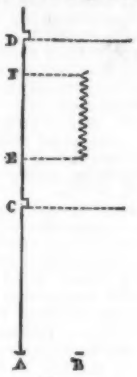


FIG. 5.

the case, A is the tracing of the chronograph, B the optical tracing, and C and D the two signals, while E is the beginning of the luminous action, and F the end of it.

It will be seen, then, that the image is not produced at the beginning and end of the exposure, and all the irregularities in illumination indicated by theory are found to have no action in practice.

Are not these results curious? It would seem, *a priori* in fact, as if, with plates prepared for instantaneous negatives, as soon as the observation partially ceases, the image ought to begin to form, and to continue even after the beginning of the obturation.

The phenomenon is not well explained; and while naturally leaving to Mr. Londe the responsibility for his experiments (although there is not reason to doubt his results), it has appeared to us that a description of his ingenious apparatus and a statement of the facts revealed by them were worthy of being put upon record. —*La Lumiere Electrique.*

THE WIRE CREEPER.

THERE are very few who can at all appreciate the difficulties, annoyance, and expense that are encountered in the erection and fixing of telegraph, telephone, and other similar wires. More especially is this the case in large cities, where buildings are crowded together in a fashion sometimes useful to the linemen, but more often not, and where the number of wires already put up only add to the difficulties. To obviate much of the inconvenience constantly being met with, there has been designed and brought out the extremely neat and useful instrument which we illustrate below. Its chief advantage lies in the readiness with which fresh wires may be run by its help across spaces where lines already exist, there being effected a considerable reduction in time and labor of erection, as well as less risk of making permanent contacts with other wires. The principle of this creeper is familiar in the guise of certain mechanical toys; but such improvements have been made that it is practically a new invention. Fig. 1 shows the apparatus as used. It consists essentially of two castings, into one of which two hollow tubes are fastened. Upon these tubes is loosely fitted the second casting, which is free to move backward and forward along them, but cannot slide completely off, owing to the crosspiece at the end. The two castings are each provided with a clutch, or small trap door (see Figs. 2 and 3), both opening the same

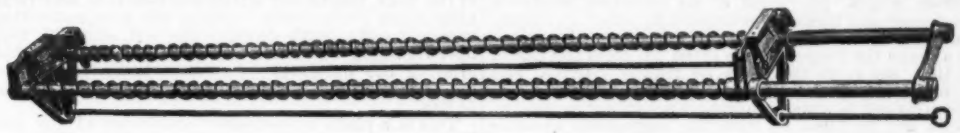


FIG. 1.

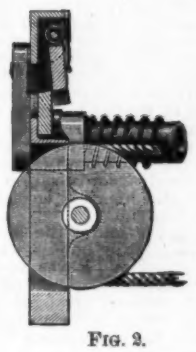


FIG. 2.

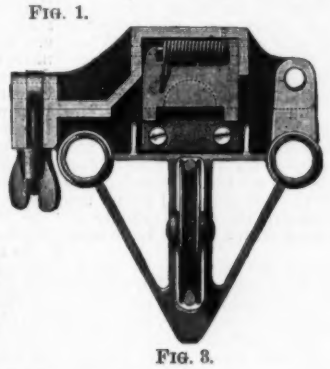


FIG. 3.

THE WIRE CREEPER.

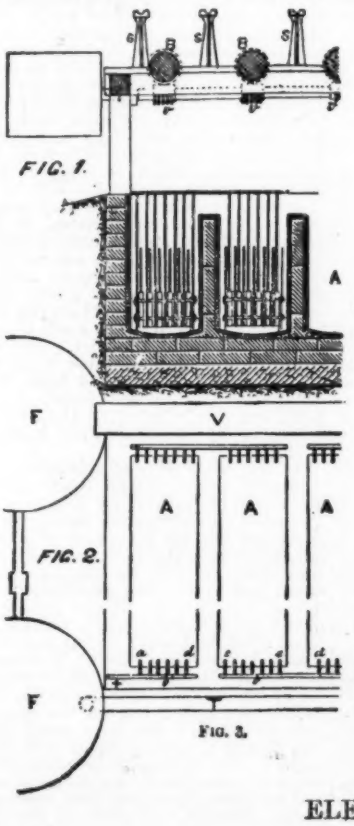
way, so that when the apparatus is placed upon a wire it will only move in one direction, any effort to move it in the other merely serving to fix the whole thing more firmly by a stronger grip of the clutches. The castings are normally kept apart on the tubes by means of spiral springs, as shown; but a cord is provided for drawing them together against the tension of the springs. By loosening the wing nut and lifting up the hinged part, the apparatus can be put upon any wire already erected, the fixed block being in front. A long cord is then attached to the following block, and, passing over the pulley, is brought back to the operator, who pulls it, and thereby both fixes the front block to the wire and draws up the following block against the tension of the springs. On relaxing the pull, the springs tend to force the latter block backward; but the clutch comes into play and fixes it to the wire. The springs consequently force the front block and the tubes onward until once more extended; then the cord is again pulled, the front block fixed, the following block drawn up, and the springs compressed, until they release the front block and push it onward, when the pull is relaxed. Each pull sends the apparatus about eighteen inches along the wire to the opposite support. When it reaches the latter, the lineman waiting to receive it takes it off the wire, and by means of the cord which it has carried over, draws also the wire which is to be run across the space. This is usually done by attaching both wire and cord to a pulley made to run on the wire already erected. The apparatus has been so designed as to reduce its weight to the smallest amount consistent with strength.—*Industries.*

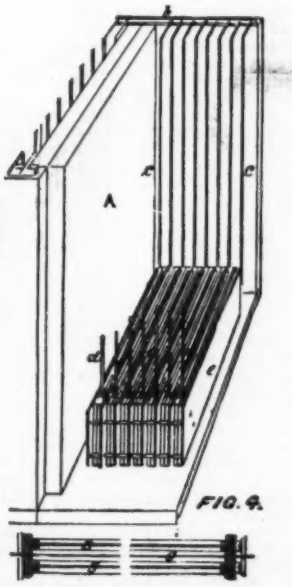
ELECTRICAL BLEACHING PROCESS.

THE material to be bleached is exposed to the action of a bath containing chloride of magnesium, through which is passed an electrical current that, according to the patentee, will react in the following way: The magnesium chloride is decomposed, and hypochlorous acid and magnesia are formed. In the presence of this base the acid is split up into chloric acid and chlorous acid, the former combining with magnesia to form chlorate and the latter to form chlorite of magnesia. But these two salts are again decomposed by the electrical current, and form again chloric and chlorous acids, while magnesia is deposited at the negative pole. The free acids will then react on the material to be bleached and decolorize the same. The free chlorine combines with hydrogen and hydrochloric acid, which then converts again the magnesia into the chloride, which re-enters the reaction as before. The concentration of the magnesium chloride recommended is 16° Be.

The magnesium chloride is found in the vats, A, Figs. 1 and 2, which are divided from each other by brick partitions, which have been covered with cement. Over the vat is a wooden stand to hold the wooden rollers, B, which are put in movement by machinery, V. Near these rollers are the columns, S, with the object of lifting up the rollers when they are removed in order to put on them or take away the material which has to be bleached. In the vats are found the zinc plates, C, Figs. 3 and 4, on which a copper strip, C, has been soldered on; this is connected with the principal conductor, and is covered with varnish or caoutchouc to be isolated from the solution. It has on its ends two holes, *t*, through which it can be connected.

The positive electrode consists of a platinum plate, D, which is inclosed in a wooden frame, and on one side of which a copper strip has been soldered on, which is then in connection with the conductor. In the frame and round the copper rod, *d*, there is an empty space in which fused sulphur has been run in order to isolate the soldering and prevent it from being attacked by the liquor. The rest of the copper rod, *d*, is isolated by means of varnish or India rubber. The number of electrodes varies according to the intensity of the current, which is allowed to go through the bath with a minimum of electromotive power. Fig. 2 shows the cut of the vats, A, with the arrangement for the conductors, which are formed by C and C', and





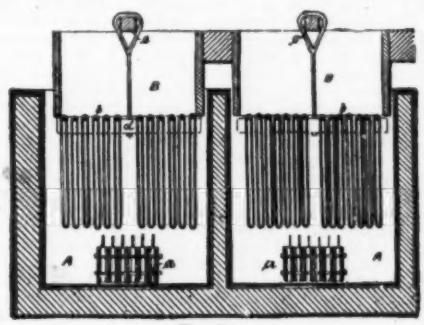


FIG. 5.

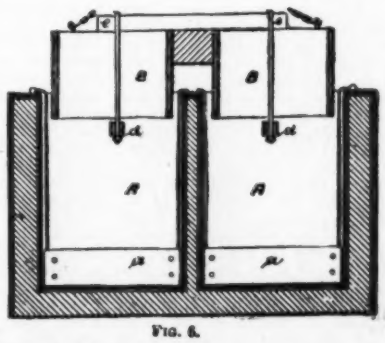


FIG. 6.

ELECTRICAL BLEACHING APPARATUS.

are connected by means of the copper strips of the electrodes. The pipe, T, brings the magnesium chloride from the reservoir, E, into the vat, A, while through an opening, N, the solution can be taken from the vat, A, into the tank, E, in order to allow it to settle. A pump, H, lifts the clear liquor from the tank, E, into the tank, F.

Figs. 5 and 6 show an apparatus for the bleaching of yarns, which are put on sticks. Each cemented vat contains the required arrangement, A, for the electrical current. Above the vats is a frame, B, which is provided with wooden sticks, C, for the holding of the yarn; these sticks are kept in their place by a cross-piece, which runs through their middle and which is itself kept in its place by another cross-piece, E. This latter belongs to a frame, C, on which all frames, B, have been fixed. This frame hangs by a chain from a pulley, which, by means of an eccentric, receives a backward and forward movement in order to agitate the yarn in the vats during the operation. By means of a crane the frames can be lifted up from the baths, so that the yarns can thus be readily removed and brought outside the vat to drain. The bleaching vats are arranged in rows, in numbers according to requirement, and are filled up with the magnesium chloride solution, through which then the electrical current is allowed to pass. Based on experience, the inventor recommends the construction of a row of 20 vats. When the bath has acquired, by means of the electrical current, such bleaching strength as may be required, as shown by the proper chemical test made, the electrical current is stopped, and the material, either on the rollers or the yarn on the sticks, is bleached in the usual way. It is also possible to bring all the liquors of the different vats into one, and then conduct the bleaching in the ordinary way. It is also advisable from time to time to be able to invert the current and bring the positive pole for a few minutes on the negative plate, in order to remove any sediment which might have been formed.

The claim of the patentee is for bleaching of textile fabrics and paper material by a process which consists in passing an electrical current through a bath containing a solution of magnesium chloride, and, after the formation of chloric and chlorous acids, to effect the bleaching either in the same vessel or in another one, and utilizing the same liquor over and over again for the same purpose.—*Centralblatt fur die Textil Industrie; Textile Manufacturer.*

THE ROYAL MINT.

THE first, and certainly one of the most interesting excursions in connection with the present meeting of the Institution of Mechanical Engineers was the visit paid on August 17 to the Royal Mint. After the luncheon at the Westminster Town Hall, a large number of members found their way to Tower Hill, where they were conducted through the various departments of our great national coining establishment, and had an opportunity of seeing many of the processes there carried on.

As most of our readers are doubtless aware, great alterations have been made in the Mint within the last four years. Up to the year 1881, the appliances and arrangements were confessedly insufficient and unfitted for the purpose of producing the national currency. For twenty years or more the subject had been under discussion, and it would perhaps be difficult to find a much more impressive instance of British official procrastination, and the grotesque manner in which we manage such matters in England, than the history of the reorganization of the Mint. After many years of importunity, the Deputy Master of the Mint had succeeded in getting the matter taken up, and in 1870 the Treasury suggested that the establishment should be removed to Somerset House. After a formal inquiry had been held, this suggestion was found to be impracticable, and the proposal was put forward that a site should be acquired on the Thames Embankment. A bill was introduced in Parliament, and was referred to a select committee of the House of Commons, but was ultimately adversely voted upon in a committee of the whole House. This closed the question for the year 1871. In 1872 and 1873 the application was renewed, but the bills were not carried to a second reading. After this the First Commissioner of Works was directed by the Treasury to consider whether the Mint could not be wholly or in part reconstructed on its present site; but whatever may have been his report, it was rendered quite useless or unnecessary by the Deputy Master declaring that the statutory obligation of keeping the nation supplied with coin could not be carried on if the existing premises and machinery were pulled down, and others could not be erected on the same spot until they had been removed. The next step was to establish an inquiry as to the possibility of making a new Mint inside the Tower, but this again was found to be out of the question. Another bill was accordingly introduced in Parliament, but after the second reading was abandoned. Notices were given in the following autumn with a view to returning to the old Thames Embankment scheme.

The business, however, was not followed up, and the matter was allowed to rest for four years. At the end of this time, the Treasury, through the First Commissioner of Works, negotiated with the City of London for the purchase of the original proposed site on the Thames Embankment. The matter having been settled, the Treasury went to Parliament for authorization to pay over the money, but the collective wisdom was either too busy or too obstructed—for those were the golden days of Messrs. Biggar and Parnell—to attend to the matter, so the business was again shelved. Next year the bill was once more introduced, and passed the Lords. On its introduction to the Commons it was referred to a select committee, and the solemn farce entered on the second stage of its existence. The instructions to the committee were "to consider and report upon the condition of the buildings, machinery, and appliances of the Royal Mint, and whether such alterations and improvements as may be required in them can be made upon the present site of the Royal Mint, or is it desirable that new buildings should be erected upon the site proposed, . . . or elsewhere." As a preliminary step, the First Commissioner of Works called to his aid no less a power than the universal authority of Sir Frederick Bramwell, who, in an exhaustive report, agreed, as might have been expected, with the Mint officials in their conclusion that a shift should be made to the site selected on the Embankment.

The Commission, with the First Commissioner as chairman, having met, proceeded to collect information, and the usual rigmarole was gone through. We need only, however, refer to the evidence of two witnesses—that of the Deputy Master and that of the Governor of the Bank of England. The former authority based his opinion as to the advisability of removal on the "necessity which existed, especially in view of a large recoinage of gold, for making provision for a far greater out-turn." Mr. Grenfell, the Governor of the Bank, stated that the stock of gold coin held by the Bank was abnormally large, and no inconvenience would arise if the Mint were to cease coining for a year or even more. This statement, which appears to have surprised no one more than the Master of the Mint, practically settled the question, and thus, after about twelve years' talking, the Mint authorities were allowed to settle down to the not, after all, very overwhelming business of erecting new premises and altering the buildings to contain them. The total amount required for machinery and buildings was 30,000*l.*

This is a plain, unvarnished statement of the preliminary proceedings for bringing the Royal Mint to a state of efficiency. If some apology is due to our readers for telling so common and ordinary a tale, the narration may not be without its use in the present day, when public opinion is being drawn to some other Government departments. It may be added that for a year previous to the date of the Commission of Inquiry, the Bank of England, which practically takes all the gold coined, had not sent any gold to the Mint to be coined; and it may occur to plain men to wonder whether the whole business could not have been settled by five minutes' conversation between the Master of the Mint and his only customer, the Governor of the Bank of England.

In making a tour of the Mint, one is naturally first shown the melting houses, where the first operations are performed, and it was here the visitors were taken on their arrival. For melting silver and bronze there are eight furnaces, arranged in two benches on each side of the house, and six smaller furnaces in one bench at the end, the latter being used for bronze only. The operations are carried on in the usual way, Morgan's plumbago crucibles being used. A pot of silver is about 3,000 oz., while 2 cwt. of bronze goes to a charge. In the smaller furnaces for bronze, ½ cwt. pots are used. An assay piece is cut off the first and last bar of each pot, and the bars are only taken into use after they have been passed by the assay office. A stopped pot is a very rare event, there not being above a dozen in a year, if so many. Standard silver for coinage is composed of 925 parts of silver and 75 parts of copper. The alloy for bronze money consists of 95 parts of copper, four of tin, and one of zinc. The Mint price of silver coin is 5s. 6d. per ounce, and as the market price is under 4s., the business should be one of fairly profitable proportions.

When the melting of the metal is complete, the crucibles are taken from the furnace by means of a hand crane and placed in a tilting cradle. This consists of an iron frame to fit the crucible, and is supported on fixed standards. An iron carriage which holds the moulds, of which about three dozen are placed in each carriage, is run up under the crucible upon rails. The moulds are of iron, and the two parts are forced together by means of a wedge-shaped bar, so that all can be taken apart, and the ingots exposed at one operation. The crucible is tilted in its frame by means of a geared quadrant and pinion. On the top of the mould carriage there is a rack, and to gear into this is a pinion supported by the standards which also support the crucible-tilting cradle. By turning a handle, the mould carriage is traversed through the rack and pinion gearing, in front of the crucible, so as to bring each mould into position as required for filling.

In pouring silver, the operator judges when the mould is full by the sound, and powdered charcoal is placed on the molten metal in the pot to prevent oxidation. In former times, the bars of silver were cast approximately square in section, but the present superintendent of the operative department, Mr. Robert A. Hill, has introduced a method of casting in flat strips, the object being to do away with a good deal of annealing required when the thicker bars had to be passed so often through the rolls in order to reduce them to the requisite gauge. After the bars are cast they are trimmed up by means of shears and rotating files, the waste being of course carefully collected.

From the silver and bronze melting house we pass on to the room where the metal is weighed up. There are here two very beautiful balances, by De Grave, Short & Farmer, one for silver and the other for gold. The bronze is weighed on an ordinary weighing machine by the same firm. The gold balance will weigh a pot of metal, consisting of 1,200 oz., within 0·01 oz. troy. As may be imagined, great care is taken to keep these balances accurate, and they are tested every day. The heat of the sun on one end of the beam, were they exposed to its rays, would cause what would amount to a very serious error in the returns. The silver balance weighs 3,000 oz. troy, and turns to 0·05 oz. The manner of leveling the beam in these scales, and the construction of the beam itself, together with many other points of detal, are well worth attention, but it would be difficult to describe them without diagrams.

The gold melting house is on the opposite side of the balance room. There are two benches of four fires each, the metal being melted in plumbago crucibles each holding 1,200 oz., about 50,000 oz. being an average day's melting. There are about nine one-sovereign bars in a pot, or about eleven to twelve half-sovereign bars. The moulds are set up in a carriage similar to that already described, but the pots are poured by hand, being simply slung in a tackle from overhead. The cast bars are sheared and then trimmed by rotary files, as in the case of silver.

In addition to the furnaces already mentioned, there are on the other side of the room four Piat's patent furnaces. In these the firebrick furnace is inclosed in a wrought-iron casing, and the whole is made to run on wheels. When the metal is being melted, the furnace is run back until an opening in the top makes joint with the flue, so as to obtain the necessary draught. The top of the furnace is made with a lip, and into this the lip of the crucible fits (the crucible lip being extra long), so that the two lips form a continuous spout. When the metal is ready to pour, the furnace is run forward on its wheels until in position over the moulds, and the furnace with the crucible inside is tilted by means of gearing attached for the purpose. In this way the molten gold is poured without taking the pot out of the furnace and giving the metal time to cool, and the chance of oxidation is also much lessened.

We now pass to the No. 1 rolling room, where the operations of rolling for bronze coin are carried on. Here there are six pairs of rolls. The first two are used as breaking-down rolls, in which the bars are reduced in thickness. These are ordinary chilled rolls 16 in. in diameter. The next pair are reducing rolls 14 in. in diameter, while the finishing rolls are 12 in. in diameter. Both rolls are worked by gearing, the top roller having a shaft projecting beyond the standard on one side, while the bottom roller shaft runs out on the other side. Both shafts are worked by spur gearing from the same countershaft, which runs beneath the floor, and as the wheels are the same size, the rolls run at equal speeds. In reducing the bar, the rolls are brought closer together after each pass by means of worm and wormwheel gearing and a vertical screw. These are actuated by hand-wheels on the top of the standards, the main bearing being carried in a slide. The bars are brought in from $\frac{5}{16}$ in. to $\frac{1}{16}$ in. thick, 16 in. long, and 4 in. wide. They are rolled down to fillets of $\frac{1}{16\frac{1}{16}}$ in. for pennies, and ten sizes less for half-penny fillets. After passing the breaking-down rolls, the bars are annealed in ovens placed conveniently at the back, and are then dipped in dilute sulphuric acid to take off the oxide scale. After the rolling operations are completed, the fillets are cut off at the ends to gauge by a pair of circular cutters, and are then trimmed up by rotary files.

We now pass through the cutting and drag room, to which we shall return again presently, to No. 2 rolling room, where silver and gold are rolled. This is a comparatively new room, being part of the 1882 extension. The new machinery here is by Maudslay, Son & Field. The distinctive feature in the design of the rolls here is that the top roll runs free, being driven by the friction of the bar as it passes through, impelled by the bottom roll, which is actuated by gearing. The regularity in weight of the blanks ultimately stamped from the fillet, is, naturally, largely affected by the uniformity of the thickness of the fillet. It was found that when both rolls were driven by gearing, a variation in the speed of rotation was caused by the necessarily imperfect action of toothed wheels. Such irregularity caused the fillet to vary in thickness, for, the longer any part is subjected to the pressure, the more it becomes compressed or spread out by the action. In America this difficulty is met by driving the rolls by belts in place of geared wheels, and in order to obtain the same results the top roll runs loose as mentioned. There is, however, a difficulty in entering the bar between the rolls, and in order to overcome this a ratchet arrangement has been attached which is worked by hand until the bar is fairly entered. We do not know what success has attended this plan, but we noticed in one pair of rolls, gearing has been added for driving the top roll, and provision has been made in another pair for adding the necessary wheels for the same purpose. Possibly the use of helical toothed wheels might meet the difficulty. Very probably such gearing has been used in turning down the chilled rolls of the mills in question. In two other sets of rolls in this room there are long toothed wheels for working one roll from the spindle of the other, the rise and fall thus being allowed for. This, we should think, would give a somewhat irregular fillet, although on this point we have no information. In the fine rolls the varying distance of the two apart is regulated by a wedge arrangement actuated by a screw and hand-wheel.

We now pass to the cutting and drag room before referred to. Here the fillets of all three metals are treated when brought from the rolling rooms. For gold and silver they are passed through another pair of rolls to give them an extra finish, after which they are taken to the drag-bench. The function of this machine is to reduce the fillets to uniform thickness. Even in the most carefully rolled strips, there must be some variation in thickness, however perfect the rolls may be. For instance, the thickness cannot be the same at the edges, where the resistance to spreading sideways is less, and the same rule applies to the ends. The differences may be so small as not to be of practical importance in ordinary metal work, but in the case of fillets for coining, especially with gold, such variations exert quite an important influence. For instance, if a half-sovereign blank is $\frac{1}{2000}$ of an inch above or below the standard gauge, it will be beyond the limit of accuracy required. The drag-bench is designed to correct any such irregularities. It consists first of a pair of hardened steel cylinders prepared with great care, so that their surfaces are exactly parallel. They are set the exact distance apart necessary to give the required thickness to the fillet. These cylinders do not revolve, and through them the fillet is dragged by means of a chain to which a slip is attached, the latter grasping the end of the fillet. This apparatus is well known, some of the machines in use bearing the name of H. Maudslay & Co., and being dated 1816. After being dragged, a blank is punched out of each fillet by hand, and this is taken to the trier, who tests it for thickness by weight. The bronze fillets are not dragged.

On the other side of this room are some new machines by Messrs. Ralph Heaton & Sons, of Birmingham, erected within the last two or three months. These are for cutting the blanks out of fillets. The latter are fed up by a pair of live rollers, and two punches arranged side by side take out the small circular disks required for coining. When the strips of metal pass into these machines, they disappear as fillets, the circular blanks falling into receptacles placed to catch them below, while what remains of the fillets after the blanks are cut out is dragged away by a second pair of live rollers. It is made up in convenient bundles to be taken back to the melting room.

The blanks are now taken to the marking machines, to have the raised rim on the periphery, which protects the finished coin from wear, formed upon them. To effect this, a pile of blanks are placed in a spout or hopper. An automatic arrangement feeds them forward one at a time into a slide. Down this they pass, and are taken by a steel disk revolving in a vertical plane. Parallel to the face of the disk is a block of

steel, and both disk and block have a groove cut in their faces, such grooves being the segments of corresponding circles. The bottoms of these grooves are set at a distance apart somewhat less than the diameter of the blank, and as the latter descends the feed spout in a horizontal position, it is caught between the disk and the block, is caused to roll in the curved grooves, and is therefore upset on its periphery.

The blanks are now in a form to be taken to the coining presses, but before this is done they have to be annealed, so that they may be softened to take the impression. They are put in pots and covered with charcoal, and then placed in coal-heated furnaces. After they have been cleaned in a shaker with sawdust and pickled in dilute acid, they are ready for the presses.

We now pass to the coining-press room, where there are fourteen new coining presses by Ralph Heaton & Sons, of Birmingham. These form the chief feature of the 1882 improvements. Up to that date the old screw presses were used, and were the chief obstacle to rapid production. We fear it would be impossible to give an adequate idea of the action of these machines without somewhat elaborate drawings. They work by means of a crank and lever arrangement, the feed being a leading feature. They were made, we understand, to designs taken from German machines, and will turn out as many as 120 coins a minute, while, we believe, the old screw presses could not work beyond sixty to seventy pieces a minute. Both sides of the coin are stamped at one operation. We may here state that these presses and the other details of new machinery were introduced by Mr. Hill, the superintendent of the operative department.

The weighing room is an interesting feature in the Mint. Here are thirty-five of Cotton's automatic weighing machines, a great number of which have been made in the Mint workshops; and very pretty pieces of mechanism they are. This machine has been the favourite theme of encyclopedia and text-book compilers, and must be too familiar to a large number of our readers to require describing at length here. As is well known, the arrangement was originally devised by Mr. Cotton for automatically detecting light gold in the bank of England. The apparatus is driven by power, obtained in the Mint from an atmospheric engine. The coin is fed forward on to a balance, and when weighed is projected into a spout. This spout is movable, its position being defined by the position of the balance. Thus if the coin be of standard weight it falls down the chute, the bottom of which remains over the center of three holes. If light the chute swings back to cover the "light" aperture, and if too heavy it swings in the opposite direction to the "heavy" hole. It should be mentioned that the original bank machine only tested for light coin, overweight money never finding its way out of the Mint. Improvements in detail have also been added by the Mint authorities. The machines test twenty pieces a minute, and weigh to 0·01 of a grain. The coins next pass through an inspection, in order to discover any discolored specimens.

The engines for driving the machinery consist of three pairs of vertical, inverted, direct-acting, compound-condensing engines, the cylinders being arranged tandemwise and having Corliss valves. The cylinders are 22 in. and 40 in. by 3 ft. 6 in. stroke; they give off 750 indicated horse power. There is a large machine and fitting shop for keeping the plant in order, together with smiths' shops and other departments of a like nature. The die-sinking department is also an interesting feature, but does not call for especial notice. In the museum there is a varied and highly interesting collection of coins and other articles extending over a period from the reign of Alfred the Great down to the present year. War medals, exhibition medals, and other Government work of a similar nature is done at the Mint, and examples were shown in the museum. With regard to the output of the Mint, the number of good pieces struck last year was 63,493,476, but this, we believe, was below the general annual average. The value was 3,890,153*l.* 4s. 11d.—*Engineering.*

TIME IN GEOLOGY.*

By G. H. DARWIN, M.A., LL.D., etc.

IT will, I think, be useful to avail myself of the present occasion to direct your attention to a certain group of theories, which are still in an undeveloped and somewhat discordant condition, but which must form the nucleus round which many observations have yet to be collected before these theories and their descendants can make a definitely accepted body of truth. Great as have been the advances of geology during the present century, we have no precise knowledge of one of its fundamental units. The scale of time on which we must suppose geological history to be drawn is important, not only for geology itself, but it has an intimate relation with some of the profoundest questions of biology, physics, and cosmogony. We can hardly hope to obtain an accurate measure of time from pure geology, for the extent to which the events chronicled in strata were contemporaneous is not written in the strata themselves, and there are long intervals of time of which no record has been preserved. An important step has been taken by Alfred Tylor, Croll, and others, toward the determination of the rate of action of geological agents. From estimates of the amount of sediment carried down by rivers, it appears that it takes from 1,000 to 6,000 years to remove one foot of rock from the general surface of a river basin. From a consideration of the denuding power of rivers, and a measurement of the thickness of stratified rock, Phillips has made an estimate of the period of time comprised in geological history, and finds that, from stratigraphical evidence alone, we may regard the antiquity of life on the earth as being possibly between 38 and 96 millions of years. But there is another theory which is precise in its estimate, and which, if acceptable from other points of view, will furnish exactly what is requisite. Mr. Croll claims to prove that great changes of climate must be brought about by astronomical events of which the dates are known or ascertainable.

The perturbation of the planets causes a secular variability in the eccentricity of the earth's orbit, and we are able confidently to compute the eccentricity for many thousands of years forward and backward from to-day, although it appears that, in the opinion of Newcomb and Adams, no great reliance can be placed on the values deduced from the formulæ at dates so remote as those of which Mr. Croll speaks. According to Mr. Croll, when the eccentricity of the earth's orbit is at its maximum, that hemisphere which has its winter in aphelion would undergo a glacial period. Now, as the date of great eccentricity is ascertainable, this would explain the great ice age, and give us its date. Without going far into details, it may be said that the various concurrent causes result in one fundamental proposition with regard to climate, which must be regarded as the keystone of the whole argument. That proposition amounts to this—that climate is unstable. Mr. Croll holds that the various causes of change of climate operate *inter se* in such a way as to augment their several efficiencies. Thus the trade winds are driven by the difference of temperature between the frigid and torrid zones, and if from the astronomical cause the N. hemisphere becomes cooler, the trade winds on that hemisphere encroach on those of the other, and the part of the warm oceanic current which formerly flowed into the cold north zone will be diverted into the S. hemisphere. Thus the cold of the N. hemisphere is augmented, and this in its turn displaces the trade winds further, and this again acts on the ocean currents, and so on; and this is neither more nor less than instability. But if climate be unstable, and if from some of those temporary causes, for which no reasons can as yet be assigned, there occurs a short period of cold, then surely some even infinitesimal portion of the second link in the chain of causation must exist; and this should proceed, as in the first case, to augment the departure from the original condition, and the climate must change.

In a matter so complex as the weather, it is at least possible that there should be instability when the cause of disturbance is astronomical, while there is stability in an ordinary sense. If this is so, it might be explained by the necessity for a prolonged alteration in the direction of prevailing winds in order to effect oceanic currents. However this may be, so remarkable a doctrine as the instability of climate must certainly be regarded with great suspicion, and we should require abundant proof before accepting it. Now, there is one result of Mr. Croll's theory which should afford almost a crucial test of its acceptability. In consequence of the precession of the equinoxes, the conditions producing glaciation in one hemisphere must be transferred to the other every 10,000 years. If there is good geological evidence that this has actually been the case, we should allow very great weight to the astronomical theory, notwithstanding the difficulties in its way. Mr. Croll has urged that there is such evidence, and this view has been recently strongly supported by M. Blytt. Other geologists do not, however, seem convinced of the conclusiveness of the evidence. Ocean currents play a most important part in these theories, but at this moment our knowledge of the principal oceanic circulation, and of its annual variability, is very meager. In the course of a few years we may expect a considerable accession to our knowledge, when the meteorological office shall have completed a work but just begun, viz., the analysis of ships' logs for some sixty years, for the purpose of laying down in charts the oceanic currents. With regard to the great atmospheric currents, even the general scheme is not yet known.

Nearly thirty years ago, Professor James Thomson gave before this association, at Dublin, an important suggestion on this point. As it has been passed over in complete silence ever since, the present seems to be a good opportunity of redirecting attention to it. According to Halley's theory of atmospheric circulation, the hot air rises at the equator and floats north and south in two grand upper currents, and it then acquires a westward motion relatively to the earth's surface, in consequence of the earth's rotation. Also the cold air at the pole sinks and spreads out over the earth's surface in a southerly current, at first with a westerly tendency, because the air comes from the higher regions of the atmosphere, and afterward due south, and then easterly, when it is left behind by the earth in its rotation.

Now, Professor Thomson remarks that this theory disagrees with fact, in as far as that, in our latitudes, the winds, though westerly, have a poleward tendency, instead of the reverse. In the face of this discrepancy, he maintains that "the great circulation already described does actually occur, but occurs subject to this modification, that a thin stratum of air on the surface of the earth in the latitudes higher than 30°—a stratum in which the inhabitants of those latitudes have their existence, and of which the movements constitute the observed winds of those latitudes—being, by friction and impulses on the surface of the earth, retarded with reference to the rapid whirl or vortex motion from east to west of the great mass of air above it, tends to flow toward the pole, and actually does so flow, to supply the partial void in the central parts of that vortex, due to the centrifugal force of its revolution. Thus it appears that in the temperate latitudes there are three currents at different heights—that the uppermost moves toward the pole, and is part of a grand primary circulation between equatorial and polar regions; that the lowermost moves also toward the pole, but is only a thin stratum forming part of a secondary circulation; that the middle current moves from the pole, and constitutes the return current for both the preceding; and that all these three currents have a prevailing motion from west to east."

Such, then, appears to be our present state of ignorance of these great terrestrial actions, and any speculations as to the precise effect of changes in the annual distribution of the sun's heat must be very hazardous until we know more precisely the nature of the thing changed. And now let us turn to some other theories bearing on this important point of geological time. The arguments which Sir William Thomson has adduced in limitation of geological time are of three kinds.

I shall refer first to that which has been called the argument from tidal friction. Since water is not frictionless, tidal oscillations must be subject to friction, and an inevitable result of this is that the diurnal rotation of the earth must be slowly retarded. No passage in Thomson and Tait's "Natural Philosophy" has excited more general interest than that in which Adams is quoted as showing that, *with a certain value for the secular acceleration*, the earth must in a century fall behind a perfect chronometer, set and rated at the beginning of the century, by twenty-two seconds. In the second edition this passage has been rewritten, and the last sentence of the paragraph runs as follows:

"It is proper to add that Adams lays but little stress on the actual numerical values which have been used in this computation, and is of opinion that the amount of tidal retardation of the earth's rotation is quite uncertain."

Thus, in the opinion of our great physical astronomer, a datum is still wanting for the determination of a limit to geological time, according to Thomson's argument. However, subject to this uncertainty, with the values used by Adams in his computation, and with the assumption that the rate of tidal friction has remained constant, then a thousand million years ago the earth was rotating twice as fast as at present. In the last edition of the "Natural Philosophy" the argument runs thus:

"If the consolidation of the earth took place then or earlier, the ellipticity of the upper layers (of the earth's mass) must have been $\frac{1}{230}$, instead of about $\frac{1}{305}$, as it is at present. It must necessarily remain uncertain whether the earth would from time to time adjust itself completely to a figure of equilibrium adapted to the rotation. But it is clear that a want of complete adjustment would leave traces in a preponderance of land in equatorial regions. The existence of large continents, and the great effective rigidity of the earth's mass, render it improbable that the adjustment, if any, to the appropriate figure of equilibrium would be complete. The fact, then, that the continents are arranged along meridians, rather than in an equatorial belt, affords some degree of proof that the consolidation of the earth took place at a time when the diurnal rotation differed but little from its present value. It is probable, therefore, that the date of consolidation is considerably more recent than a thousand million years ago."

It will be observed that the argument reposes on our certainty that the earth possesses rigidity of such a kind as to prevent its accommodation to the figure and arrangement of density appropriate to its rotation. In an interesting discussion on subaerial denudation, Croll has concluded that nearly one mile may have been worn off the equator during the past twelve million years, if the rate of denudation all along the equator be equal to that of the basin of the Ganges. Now, since the equatorial protuberance of the earth when the ellipticity is $\frac{1}{305}$ is fourteen miles greater than when it is $\frac{1}{230}$, it follows that 170,000,000 years would suffice to wear down the surface to the equilibrium figure. Now, let these numbers be halved or largely reduced, and the conclusion remains that denudation would suffice to obliterate external evidence of some early excess of ellipticity. If such external evidence be gone, we must rely on the incompatibility of the known value of the precessional constant with an ellipticity of internal strata of equal density greater than that appropriate to the actual ellipticity of the surface. Might there not be a considerable excess of internal ellipticity without our being cognizant of the fact astronomically? And, further, have we any right to feel so confident of the internal structure of the earth, as to be able to allege that the earth would not through its whole mass adjust itself almost completely to the equilibrium figure? Tresca has shown, in his admirable memoirs on the flow of solids, that when the stresses rise above a certain value the solid becomes plastic, and is brought into what he calls the state of fluidity. I do not know, however, that he determined at what stage the flow ceases when the stresses are gradually diminished. It seems probable, at least, that the flow will continue with smaller stresses than were initially necessary to start it. But if this is so, then, when the earth has come to depart both internally and externally from the equilibrium condition, a flow of solid will set in, and will continue until a near approach to the equilibrium condition is attained. When we consider the abundant geological evidence of the plasticity of rock, and of the repeated elevation and subsidence of large areas on the earth's surface, this view appears to me more probable than Sir William Thomson's.

On the whole, then, I can neither feel the cogency of the argument from tidal friction itself, nor, accepting it, can I place any reliance on the limits which it assigns to geological history. The second argument concerning geological time is derived from the secular cooling of the earth. Sir William Thomson, in his celebrated essay on this subject, concludes that "for the last 96,000,000 years the rate of increase of temperature underground has gradually diminished from about $\frac{1}{18}$ to about $\frac{1}{70}$ of a degree Fahrenheit per foot." The present argument as to the date of the consolidation of the earth reposes on the hypothesis that the earth is simply a cooling globe, and there are reasons why this may not be the case. The solidification of the earth probably began from the middle and spread to the surface. Now, is it not possible, if not probable, that after a firm crust had been formed, the upper portion still retained some degree of viscosity? If the interior be viscous, some tidal oscillations must take place in it, and these, being subject to friction, heat must be generated in the viscous portion; moreover, the diurnal rotation of the earth must be retarded. Some years ago, in a paper on the tides of a spheroid viscous throughout the whole mass, I estimated the amount and distribution of the heat generated, while the planet's rotation is being retarded and the satellite's distance is being increased. It then appeared that on that hypothesis the distribution of the heat must be such that it would only be possible to attribute a very small part of the observed temperature gradient to such a cause. Now, with a more probable internal constitution for the earth in early times, the result might be very different. Suppose, in fact, that it is only those strata which are within some hundreds of miles of the surface which are viscous, while the central portion is rigid. Then, when tidal friction does its work, the same amount of heat is generated as on the hypothesis of the viscosity of the whole planet; but instead of being distributed throughout the whole mass, and principally toward the middle, it is now to be found in the more superficial layers.

In my paper it is shown that, with Thomson's data for the conductivity of rock and the temperature gradient, the annual loss of heat by the earth is [illegible] part of the earth's kinetic energy of rotation. Also, if

* Address by the President, Professor G. H. Darwin, of the Mathematical and Physical Section, British Association, Birmingham, September, 1886.

by tidal friction the day is reduced from D_0 hours to D hours, and the moon's distance augmented from II_0 to II earth's radii, the energy which has been converted into heat in the process is

$$\left(\frac{D}{D_0}\right)^2 - 1 - 8{\cdot}84\left(\frac{1}{II} - \frac{1}{II_0}\right)$$

times the earth's kinetic energy of rotation. From these data it results that the heat generated in the lengthening of the day from twenty-three to twenty-four hours is equal to the amount of heat lost by the earth, at its present rate of loss, in 23,000,000 years. Now, if this amount of heat, or any sensible fraction of it, was actually generated within a few hundred miles of the earth's surface, the temperature gradient in the earth must be largely due to it, instead of to the primitive heat of the mass. Such a hypothesis precludes the assumption that the earth is simply a cooling mass, and would greatly prolong the possible extension of geological time. It must be observed that this view is not acceptable, unless we admit that the earth can adjust itself to the equilibrium figure adapted to its rotation. It seems also worthy of suggestion that our data for the average gradient of temperature may be somewhat fallacious. Recent observations show that the lower stratum of the ocean is occupied by water at near the freezing temperature, while the mean annual temperature of the earth's surface, where the borings have been made, must be at least thirty degrees higher. It does not, then, seem impossible that the mean temperature gradient for the whole earth should differ sensibly from the mean gradient in the borings already made.

The foregoing remarks have not been made with a view of showing Sir William Thomson's argument from the cooling of the earth to be erroneous, but rather to maintain the scientific justice of assigning limits of uncertainty at the very least as wide as those given by him. Professor Tait cuts the limit down to 10,000,000 years; he may be right, but the uncertainties of the case are far too great to justify us in accepting such a narrowing of the conclusion. The third line of argument, by which a superior limit is sought for the age of the solar system, appears by far the strongest. This argument depends on the amount of radiant energy which can have been given out by the sun. The amount of work done in the concentration of the sun from a condition of infinite dispersion may be computed with some accuracy, and we have at least a rough idea of the rate of the sun's radiation. From these data Sir William Thomson concludes: "It seems, therefore, on the whole, most probable that the sun has not illuminated the earth for 100,000,000 years, and almost certain that he has not done so for 500,000,000 years. As for the future, we may say, with equal certainty, that inhabitants of the earth cannot continue to enjoy the light and heat essential to their life for many million years longer, unless sources now unknown to us are prepared in the great storehouse of creation." This result is based on the value assigned by Pouillet and Herschel to the sun's radiation. Langley has recently made a fresh determination, which exceeds Pouillet's in the proportion of eight to five. With Langley's value, Thomson's estimate of time would have to be reduced by the factor five-eighths. It has been suggested by Croll that the primitive solar nebula may have been hot. This heat must have arisen from the collision of two or more masses; if their relative velocity before collision was that due simply to their mutual attraction, the heat so generated is already counted in the heat generated by the concentration of the sun from a state of infinite dispersion. But if the relative velocity existed otherwise than from their mutual attraction, then the total heat in the sun might exceed that due simply to concentration. Sir William Thomson considers the hypothesis very improbable. The term improbability seems, however, almost to lose its meaning in these speculations, and at least we know by the spectroscope that actual nebulæ do consist of incandescent gases. In considering these three arguments, I have adduced some reasons against the validity of the first argument, and have endeavored to show that there are elements of uncertainty surrounding the other two; nevertheless, they undoubtedly constitute a contribution of the first importance to physical geology. While, then, we may protest against the precision with which Professor Tait seeks to deduce results from them, we are fully justified in following Sir William Thomson, who says that "the existing state of things on the earth, life on the earth, all geological history showing continuity of life, must be limited within some such period of past time as 100,000,000 years."

A RARE ORCHID.

(VANDA LOWI.)

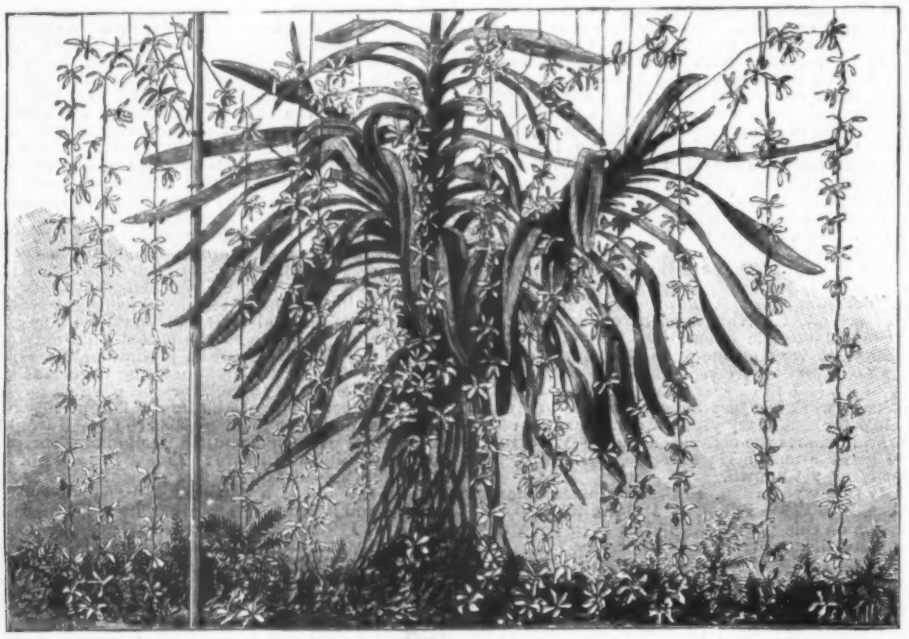
VANDA LOWI is a native of Borneo. Although introduced into Europe as long ago as 1846, it is still very rare, since the introduction of it is attended with great difficulty. It is hardy, and grows well as soon as a suitable place has been found for it. Its leaves are long, wide, and of a beautiful shining green. It is a plant of very ornamental appearance, even without flowers. It requires the same temperature and treatment that the other Vandas do, that is to say, an Indian orchid stove, with a temperature varying from 18° to 26°C., according to the season. It does very well in a bucket made of elm or pitch pine, with a compost of sphagnum, broken pottery, and bits of charcoal.

The flower stalks are very long and flexible, as are also the velvety peduncles. The down on the back of the petals and sepals is finer and sparser than that of the peduncles. This orchid presents a remarkable case of dimorphism, and this is one of its most curious features. On each flower-bearing stem, at the base, there are two (rarely three) flowers, which, in form and color, are entirely different from the others. These are of a bright golden yellow with brown dots, and have a small, pale rose colored labellum, and short and wide petals and sepals.

The remaining flowers are of a beautiful dark red, slightly spotted with cream color, and their sepals and petals are longer than in the yellow flowers. The labellum is the same. The flowers last in a perfect state for at least a month.

The specimen that we figure herewith belongs to Baron Rothschild, and was flowered by Mr. Bergmann in the hot-house of the Ferrieres estate. There was one flower found at the base of the flower stalk that was intermediate between the two varieties, and that had a sepal of the one and a petal of the other. The plant here figured is the most beautiful specimen in France, and measures 6 feet in height, not including the basket, which is 10 inches in height and 24 inches square.

It has one main stalk, from which start four strong branches that give rise to three smaller ones. It has 120 leaves, which have an average length of 28 inches, and which are all perfect as regards health and color. The seventeen flower stalks are each 8 feet long, and bear on an average from 28 to 30 blossoms, thus giving a total of about 450. This same plant, in 1880, when naturally not so strong, flowered with two stalks, and in 1883, with 11 stalks and 280 flowers—always in the month of July. It is certainly one of the most interesting plants of its order.—*La Nature.*



VANDA LOWI.

A NEW IRON OXIDIZING PROCESS.

M. DE MERITENS, the electrician who has done so much for magneto-dynamic machines, has suggested a process for rendering iron inoxidizable, of which great things are predicted in *Engineering*. The article to be protected is placed in a bath of ordinary or distilled water at a temperature of from 158° to 176° Fahr. (70° to 80° C.), through which an electric current is transmitted. The water is thus decomposed, and the oxygen combines with the metal of the article to be treated, which forms one pole of the system, while the hydrogen appears at the other electrode, which may be either the tank itself or a plate of carbon or metal. The current is only, strong enough to overcome the resistance of the circuit, and to decompose the water; for if it is too strong a powdery oxide of no adhering power is produced. If the conditions are good, however, in a very few minutes after the circuit is completed the metal darkens, and shows that the oxygen is uniting with it to produce the black magnetic oxide, which it is well known will protect the underlying metal from the action of the air. In the course of an hour or two the coating is sufficiently thick to resist the action of a scratch brush, and it will then take a brilliant polish. If iron that is actually rusty is placed in the magnetic bath, the rust is rapidly converted into the magnetic oxide. The outer coat of oxide has no adhesion; but underneath it is a coating which is actually a part of the metal itself. M. De Meritens first experimented with steel articles, and easily succeeded with them; but the treatment of wrought and cast iron was not so satisfactory, as the coating was not adhesive. After many experiments, the order of the current was reversed; the iron being changed from the anode to the cathode, and back again. It was only when distilled water was substituted for the ordinary public supply that a perfectly satisfactory result was obtained. The whole arrangement is very simple, and requires but little skill in working. By placing several baths in series, and increasing or diminishing the number in use at any time, the electromotive force of the current can be regulated without any artificial resistance. The process is expected for many purposes to supersede galvanizing, bronzing, or the Bower-Barff process of oxidation; but the cost of working it, as compared with either of these methods of protecting iron, is not stated. Where the machinery is employed for other purposes, the working expenses may be light; but if special plant has to be laid down, it will probably be rather expensive.

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